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EDITORIAL NOTES.

A REPORT is in circulation that a gun of 16.3 in. caliber and 47 ft. long has recently been tested in France that has given the enormous initial velocity to its projectile of 4,000 ft. per second. It is stated that the gun is not yet in shape for use on board ship, but that it is especially adapted for coast defense. The question that naturally arises is whether, with such a velocity, a material can be found that is sufficiently hard to enable it to pierce the armor that will be opposed to it.

A FEW weeks ago it was announced that the dynamite cruiser *Vesuvius* was doomed, that her guns were to be removed, and she was to be converted to a somewhat cumbersome gunboat. But there still seems to be a disposition to give the vessel all the benefits of the doubt, and it is probable that a further trial will be made, which it is intended shall be as conclusive as the Port Royal trials were expected to be. It will probably take some months to prepare the shells, and when this is done it is to be hoped that the cruiser will be given a trial that will stand on a par with fighting service.

THE French have certainly systematized the matter of universal expositions in a way that is worthy of the imitation of other nations. Already they are preparing for the great event of 1900, and while it may not equal the magnitude of the Chicago Fair, it will have the advantage of being thoroughly developed at all points, and showing the results of a careful and systematic forethought that is not everywhere apparent in the Windy City. Bigness is not necessarily completeness; and artistic excellence is usually the result of such long and careful preparation that its art appears to be natural.

THERE seems to be some ground for the complaints uttered in a recent letter to London *Truth*, in that steamship construction tends too much toward large and elegant saloons, with too little attention to the comforts of individuals in their state-rooms. Practically the saloons are only used at meal time, and that for a comparatively small portion of the voyage by the majority of the passengers, whereas the deck and the state-room are the abiding places of all but the gamblers, who frequent the smoking-room. The question is, therefore, very pertinently asked, whether it would not be better to curtail saloon accommodations a trifle and supply state-rooms with a few conveniences in the shape of wardrobes and drawers, in order that passengers may have more individual comfort, even though photographs of the main saloon may not show so great an extent of magnificence.

FROM time to time the question of oil burning as a fuel is brought to the front, and there are some enthusiasts who, regarding the matter from a purely mechanical standpoint, look forward to the millennium when coal heaving will be a lost art. But hard-headed calculators have shown time and again that the oil resources of the world are wholly inadequate to supply the demand for oil were it to supplant even a small percentage of the coal consumption. So the mere fact that the *James' Brand* used oil instead of coal for fuel for three days on the last trip from England to Philadelphia simply proves, what every one already knows, that it is perfectly practicable to use oil as a fuel on locomotives, steamships, and stationary boilers, and that, whether it be used or no, it is merely a question of cost; and this has thus far kept the oil out of the field except in cases of limited application.

IF any naval architect of less prominence than Mr. J. H. Biles, the designer of the *Paris* and *New York*, had given voice to the opinion that a few years hence a thirty-knot speed would be maintained for ocean service, it would have been received with a smile of semi-incredulity. But coming from Mr. Biles it is deserving of the most careful consideration. Ten knots must be added to the present speeds. Of this Mr. Biles proposes to gain two knots by the use of nickel steel instead of ordinary steel; then three and a half knots by the use of oil instead of coal as a fuel, and the remaining four and a half knots he believes can be secured by such changes in dimensions as will increase the length and draft and by improving the machinery. The length will be about 1,000 ft. and the beam 100 ft., with a draft of 30 ft. The possibility of the vessel from a mechanical standpoint may exist, but there still remains the financial aspect to be considered; and the question at once arises whether such a steamship can be made to pay, and upon this alone will its ultimate construction probably depend.

WE have alluded from time to time to the proposed plan of using the trolley system for canal boat propulsion on the Erie Canal. We understand that arrangements have been practically completed for a trial, and that the power for the preliminary work is to be furnished by the Rochester Railroad Company. This certainly seems like the most sensible solution that can be given to the canal propulsion problem. These boats are of a comparatively small tonnage, and every foot of bunker space is valuable. Then the employment of a skilled engineer adds one, or, in case of night work, two, to the crew, which very materially increases the item of expense. But by the use of the trolley system there need be but three persons aboard. The drivers and mules are dispensed with, and the motor is under the control of the helmsman, so that a cook and two men are all that will be

needed for the safe and speedy navigation of the raging "canawl." Of course this means a big company for supplying power, and possibly the absorption of the individual owners until the State canal is turned into a private enterprise; but we need not cry "wolf" until we see him, especially when the advantages to be gained from the new system are so great.

COMPOUND LOCOMOTIVES.

THE Chicago Exhibition affords an excellent opportunity of making a general review of the "state of the art" of the design and construction of compound locomotives. There are examples of nearly all the different types on exhibition, which thus admit of almost simultaneous comparison. There are a number of the two-cylinder type—that is, with a small high-pressure cylinder on one side and a large low-pressure cylinder on the other. The Brooks Locomotive Works have a four-cylinder tandem engine among those which they exhibit. The Baldwin Works are represented by a number of engines of the Vauclain type, having four cylinders, one high and one low, connected to the same cross-head on each side. The London & Northwestern Railway Company have sent one of Webb's three-cylinder engines with the two high-pressure cylinders outside and connected to the trailing pair of wheels, and a single inside low-pressure cylinder connected to a central crank on the front driving-axle. In the French department an engine like the one for the Paris, Lyons & Mediterranean Railway, which we illustrated last month, is exhibited. As shown by the engravings which were then published, it has four cylinders, the small high-pressure ones being outside the frames and coupled to the trailing driving-wheels, the axle of which is below the back end of the fire-box. The large low-pressure cylinders are inside below the smoke-box and connected to cranks on the front driving-axle.

This engine is worthy of careful study, and has some very decided advantages. There are many details which an American designer will not be likely to copy; but it is believed that the more it is studied the more there will be found to admire in its design. The details are worked out with a great deal of skill and are admirably proportioned, and any one with considerable experience in designing locomotives will see that whoever did this was a master of his occupation, even though the student of his work might not agree with all the features of the design.

The general plan of the engine has also much to recommend it if we want to use compound locomotives. To a person with what may be called fine mechanical sensibility there is something incongruous in the use of a great big cylinder on one side of a locomotive and a small one on the other. It looks, and is, lopsided. To incase the little cylinder so as to make them both *look* big is still worse, because this does not change the lopsidedness, but adds an element of humbug besides. A designer with the right kind of mechanical conscience would rather have his work look lopsided than to feel that humbug was employed to prevent it. Then, too, the enormous size of some of the cylinders which are on exhibition is objectionable. It would be difficult on many roads to get clearance enough for them, especially on six or eight-coupled engines on which they must be connected to the crank-pins outside of the coupling-rods. They are tremendously heavy, are difficult to make and to handle, and are liable to break. Their pistons and connections are correspondingly heavy and proportionately difficult to balance properly. The strains on the frames and connecting parts are increased with the size of the cylinders, although the increase may not be in the same proportion. This is also true of the tandem system; and the difficulty of balancing the reciprocating parts is as great or greater than it is on the low-pressure side of two-cylinder compounds.

In the Webb engine the low-pressure cylinder must be as large as it is for the two-cylinder system, and it is attended with the same difficulties that have been pointed out, excepting that, being located in the middle of the engine, its weight does not overhang, as it does when a cylinder is outside. The Webb high-pressure cylinders each require to be only half as big as they are on a two-cylinder engine. The difficulty of balancing is therefore lessened; but, owing to the fact that the front and back driving-wheels are not coupled on this engine, makes it impossible to use the adhesion of the front pair in starting if they should happen to stop at a dead point of the crank. The difficulty of balancing the Vauclain engines is, at any rate, no less than it is with those we have referred to.

Another feature of all these systems excepting Webb's—and it is true of simple engines also—is that the cylinder or cylinders on one side—whether it be one, as in the case of the two-cylinder engines, or two, as in the Vauclain or tandem type—at times must drive all the wheels which are coupled. In Webb's engine the high-pressure cylinders propel the rear pair of wheels, and the low-pressure cylinder turns the front pair. The front and back pairs of wheels are not connected together. The power and the strains are therefore divided. It has been pointed out that if the low-pressure crank should stop at one of its dead points, that its piston would be unable to exert any tractive power, and at a time when it is most needed. This must seriously diminish the starting capacity of these engines or add materially to the time required to start, which in some kinds of traffic is a matter of some importance.

Now, in our French four-cylinder engine none of these evils exist. The outside cylinders, which are for high-pressure steam, are of moderate size, because there are two instead of one of them, as in the two cylinder machines. The same is true of the low-pressure cylinders, and these are located between the frames when they are not likely to come in contact with any outside obstructions. Whatever advantage, if any, which inside cylinders have in being better protected from radiation of heat, their position gives them.

It will be noticed, too, that their steam-chest covers are outside, where they can easily be removed, thus giving convenient access to the valves and valve seats, the want of which is a serious objection to most inside cylinders.

The high-pressure cylinders, it will be seen, are connected to the back pair of driving-wheels, while the inside low-pressure cylinders are connected to cranks on the front driving-axle. The front wheels are thus driven by the low-pressure and the back pair by the high-pressure cylinders. The strains on the mechanism are thus divided, and its parts may be, and in this engine are, lighter than they are ordinarily on engines of this size. The coupling-rods have no work to do excepting to keep the two pairs of wheels in their proper relative positions. There is thus less strain on the parts and a consequent diminished liability to breakage.

It will be noticed, too, that the outside and inside cranks on each side of the engine are placed opposite to each other. The pistons of the high-pressure or outside cylinders on each side of the engine therefore move in opposite directions to

those in the low-pressure cylinders on the same side. This makes it possible for the reciprocating parts of the high and the low-pressure cylinders to balance each other perfectly, and gets over all the difficulty, be it great or small, which is attributed to this cause.

The high-pressure cylinders, too, are located about midway in the length of the engine; and the low-pressure cylinders, being between the frames, the disturbing effect of the steam pressure on the movement of the engine will be much less than it is on any of the types of engine referred to excepting Webb's. The French locomotive ought, therefore, to be a very steady running machine. It will have none of the difficulties either of the Webb machine in starting heavy loads.

It should be noticed, too, that the large low-pressure cylinders are inside of the frames, where they are out of the way, whereas in the other four-cylinder engines they are outside; and if the wheels are small, they come into inconvenient proximity to the ground and other obstructions.

The disadvantage of the French engine, which American engineers will be likely to object to, is the crank-axle. It is only the older living members of the master mechanics' fraternity who have had experience in the use of crank-axles in this country. The traditions of their experience still survive, however, and the younger members have inherited an aversion to them—we mean the crank-axles. In the present instance, however, something may be said in their favor. Considering the advantages which have been pointed out in the plan of the French engine, it may perhaps be reasonably asked whether past unfavorable experience with crank-axles should end all consideration of the plan by American engineers. Something may be said in defense of the crank-axle, and, in this case, some new evidence may be submitted in its favor. As has been pointed out, in the engine which has so much to commend it the crank-axle has only half the duty to perform that was expected of these organs in the old-fashioned simple four-coupled engines. In them the pistons turned the crank axles and the wheels on them. These wheels were connected to another pair by other cranks and rods. The crank-axle therefore had to perform double duty—that is, to transmit the propelling power from the cylinders to its own wheels and also to another pair, which were usually behind it. In the French engine each pair of wheels is driven by a separate pair of cylinders. The crank-axle is, therefore, subjected to only half as much of this kind of strains, and there would, therefore, seem to be less liability to breakage than there was in the crank-axles used a generation ago. The improvements and appliances used in metallurgy have given us in the steel which can be furnished for forgings to-day a material of greater strength than the iron possessed of which crank-axles were formerly made.

In other words, the question at issue is, whether the advantages which have been pointed out would outweigh the risk that we would now assume in using a crank-axle. That it is easy, in the waning light of past experience, to overestimate the latter is evident. It may be that practice which was impracticable a quarter or a half a century ago is quite safe now with the improvements in design and manufacture which have been pointed out. If there is no risk or difficulty in using a crank-axle for an engine of the general design which we have described, then, it is contended, we would have a more perfect machine than any other compound locomotive which has thus far been tried. It is true that there would be considerable extra cost involved if we compared such an engine with any of the other two or four-cylinder types in use. It would have, in the first place, a crank-axle, which is always more expensive than a straight one; and there would be duplicate cross-heads, guides, connecting-rods, and valve-gear, although, if it is practicable to operate other four-cylinder compound locomotives with single valve gears, it would not seem impossible to do it with an engine of the general plan we have been discussing.

Our article has been written for the purpose of inducing American engineers to study the design of this French engine, the opportunity of doing which is afforded them at the Chicago Exhibition, and by the publication of the engravings of it in the June number of the AMERICAN ENGINEER AND RAILROAD JOURNAL.

THE WORK OF THE MASTER CAR BUILDERS' CONVENTION.

THE annual convention of the Master Car Builders' and Master Mechanics' associations have been held, and the members are once more scattered among their homes with recollections that vary according to the standpoint from which the individual member viewed the work at Lakewood. To those for whom the convention means an annual outing, with little regard for work, the funds supplied by the committee have given ample entertainment. It is difficult to conceive of a more delightful location than that of Lakewood, or a place where the charms of water excursions can be more fully realized.

There has, however, been some criticism, as we believe there always is, regarding the extent of the entertainment provided and the amount of the assessment levied from the attendant exhibitors; and there is no doubt that a tax on each member of the "lobby" of $25 for each convention bears very heavily upon some who find it to their interest to attend these meetings. But when the early days of these conventions are remembered, and we revert to the wild go-as-you-please expenditure of some large firms, the present method of pooling the entertainment fund may be a good one, although there are differences of opinion as to the amount that should be collected.

Among the pleasant recollections, not the least will be that of the excursion to the stock farm of Messrs. Miller and Sibley, at Franklin. It is impossible, and might be somewhat out of place, to review all that was done; but the enjoyability of the trip was greatly enhanced by the close attention to the minute details of the preparation that was apparent everywhere, evidencing the business methods that have made the stock farms themselves such a success.

The sessions of the convention were well attended, though the discussions did not appear to be so vigorous and spirited as they have been at times in former years. Of course the interchange rules were overhauled, but with one exception the changes aroused but little debate. That which attracted the most attention was Rule 19, which was so changed that any car which was originally equipped with a link-and-pin coupler is to be accepted, provided the drawbars fit properly, and is to be carded only for changes made in the rear attachments. This leaves a road repairing a damaged car free to use any drawbar that may be its own standard, without carding. The old rule required a card if the link-and-pin drawbar put in was not like the one originally on the car.

The Committee on Metal for Brake Shoes failing to report, a paper was presented by Secretary Cloud reviewing the

experimental work that has been done by the Pennsylvania Railroad looking toward the settlement of this question, and having in view :

"1. A comparison of retarding power with one brake shoe per wheel and with two shoes per wheel, with the same aggregate pressure applied to the wheel in each case.

"2. A comparison of retarding power with long and short shoes, with one brake shoe per wheel in each case.

"3. A comparison of retarding power with uniform pressures by the use of cast iron, composite, and three different grades of cast-steel shoes.

"4. A comparison of the durability of the cast iron, composite, and steel shoes in continued service; also, incidentally, the relative wear of the wheels under these different shoes.

"The tests were made on a uniform grade of about 80 ft. per mile, with three cars, two of which were passenger cars and the other a dynamometer car placed between the two. The three cars together weighed about 130,000 lbs. The run was made by gravity and the start by releasing the hand brakes on the forward passenger car, and on which alone the air brake was used to stop the three cars by opening the conductor's valve. The train of three cars was allowed to run a distance of one mile by gravity with the brakes released, and the time was taken by stop watches at the start and the end of one mile to check the uniformity of the speed attained in the different tests. On passing the one-mile post the air brakes were applied to the forward car only, with the other two cars pushing, and the time and distance required to make the stop were taken and the speed was recorded by the dynamometer car. The sliding of the wheels was noted by an observer at each end of the car which was braked. The condition of the rails was dry during the trials, but the wind, which was light, was in different directions and of different velocities on different days."

It was found that there was practically the same efficiency with the two methods of braking laid down in the first section, although it appeared that the wheels were more liable to skid with two shoes applied than when there was but one. It was also noted that the riding of the car was rather easier when two shoes were applied than when there was but one, "due, apparently, to the fact that the application of the second brake beam to each pair of wheels partly counteracted the tilting of the trucks caused by the outside suspended beams." The third tests resulted in giving to the cast-iron shoe the greatest resistance, though the percentage of area of wrought iron in the composite shoe was but 7 per cent., whereas with the shoe as usually made this area is about 40 per cent. In wearing qualities, however, the cast-iron shoe fell far behind, being about twice as great as the composite, and from six to fourteen times as great as that of cast steel.

Our readers will recollect the report on the same subject that was made in 1891, which embodied the more important of the results obtained in the laboratory of the Chicago, Burlington & Quincy Railroad. Road tests were recommended at that time, but a lack of funds stood in the way of carrying them out. The association has agreed to appropriate $500 for this purpose, however, and inadequate as the amount seems to be, it will serve as a starter, and we may hope to gather from the results obtained a more accurate knowledge of frictional resistances than we now possess.

The recommendations of the Committee on Axles, Journal-boxes, Lids and Wedges were confined, for the most part, to a revision of the present drawings, urging that they be re-dimensioned, and that these be made to agree.

Congress appears to have put things into something of a muddle by the recent law regarding the height of drawbars and the time clause, wherein the American Railway Association should make its recommendation. The old standard height of 33 in. has certainly not been followed very closely, chiefly, perhaps, through the influence of certain large roads which found it convenient to use a higher standard. It appears, from the report of the committee, that whereas 79.55 per cent. of the cars reported can have their draw gear adjusted to a height of 35 in., only 36.73 per cent. can be made 33 in. This is a strange state of affairs and one that certainly calls for a readjustment of the heights. The convention has, therefore, voted to submit the heights as promulgated by the Interstate Commerce Commission—namely, 34½ in. as a maximum and 31½ in. as a minimum—to letter ballot.

The tests of the M. C. B. couplers that have been made at Altoona and Watertown have resulted in the strengthening of many weak parts of couplers, and the determination of the most suitable metal to be used for the several parts. The tests showed that the malleable iron shank is amply strong to stand the yoke or tail-bolt strains of over 125,000 lbs., but that the pivot pins should be of high carbon steel, since wrought-iron pivot pins bent after a few blows so that the knuckle was inoperative.

In the discussion there were some rather sharp statements made relative to the use of malleable iron. This naturally excited outside discussion among the supply men who are interested in the manufacture of the metal. The statement to the effect that a great deal of the malleable iron that was manufactured was little if any better than low grades of cast iron was met by the argument that malleable iron should not be judged by poor qualities, but by what can be obtained, and that a guaranteed tensile strength of 35,000 lbs. per square inch can be had.

Among the recommendations which were made by the committee appointed to report on the protection of trainmen and lettering of freight car lines was one that there should be a handhold placed at the end of flat cars just below the flooring on the end sills and directly over the rails. This was strenuously opposed by some members both in and out of the convention on the ground that it added to the danger of the trainmen instead of removing it, inasmuch as it was so low down that, with the ordinary construction of diamond truck and inside hung brakes, it would be impossible for a man to keep himself away from the wheels by taking hold at this point, and that it would be better to have nothing than such a dangerous innovation.

The report on steel-tired wheels was very brief, and was presented almost entirely in tabular form. These tables consist of the weights and prices of the several steel-tired wheels which are now upon the market, and the objections which were raised by members to the spoke wheels. From the discussion which followed it is to be gathered that the general opinion of the members is that the steel-tired wheel is the proper wheel to use on passenger traffic, as would naturally be expected from the fact that it is almost universally used on the roads of this country. There were some objections raised on the ground that the wheels were apt to shear off parts of rails and that the tires were apt to break on account of improper backing on the part of the center, but these failures are so infrequent that they might be

almost entirely disregarded; still it is to be remembered that proper care must be taken in fitting the tires to the center and heating for shrinking on.

The report of the Committee on Steel Center Sills for Freight Cars was brief, but was quite extensively illustrated by drawings of the various designs which have been used abroad, and those of the Harvey Steel Car Company. The report stated that nothing has resulted from the experience of those using such cars in this country which would lead to a strong conviction for or against steel center sills. It has, however, been found on the Lake Shore & Michigan Southern Railroad that running repairs are much less with the steel under frames. The report dealt in a few words with the experience with metallic tender frames, and seemed to convey the opinion that they were not as desirable as the wooden frames on account of their liability to distortion in case of accident, as they cause a longer delay for locomotive repairs than would be the case were wooden frames to be used. The advantages that may be expected from the use of metal center sills lie almost solely in the increased durability and the reduced cost of inspection. A metal center sill, when it is properly constructed, is equivalent to a continuous drawbar arrangement from end to end of the car, and being composed of material having high tensile strength, steel center sills require but little inspection. It is, therefore, to be expected that the use of steel center sills will reduce the cost of running repairs.

This brief *résumé* of the work of the Master Car Builders' Association is a mere outline of what was done, and is simply the general impression that was produced by the reports, which will be published in full by the society in the course of six or eight weeks.

NEW PUBLICATIONS

PUMPING MACHINERY. *A Practical Handbook Relating to the Construction and Management of Steam and Power Pumping Machines.* By William M. Barr. J. B. Lippincott Company, Philadelphia (447 pp., 6 × 9 in.).

In his preface the Author says that "this book is essentially descriptive of pump detail; no attempt has been made to enter into the theory and mathematics of pump construction." He says further that "it has been prepared for the benefit of engineers, architects, contractors, plumbers, etc., who have occasion to recommend and use pumping machinery, and who wish to inform themselves regarding pump construction."

The illustrations have been made a prominent feature, and they are numbered up to 264. The Author says that, with few exceptions, the illustrations are from pumping machinery actually constructed and in use. Most of the engravings are evidently from original drawings, but in some few places the smudgy trail of "process" reproductions is apparent, as in figs. 149 and 161.

The introduction is quite brief, less than eight pages. The second chapter is on Water Pistons and Plungers, and is illustrated with 26 engravings showing different types of piston packing and plungers. The descriptive matter is admirably clear, and gives the kind of practical details which a mechanic is most interested in knowing.

The third chapter is on Piston and Plunger-Rods, and illustrates and describes various ways of fastening piston-rods to pistons. The last part of the chapter refers to stuffing-boxes, showing several different forms for fibrous packing. Nothing is said of metallic piston-rod packing, which is now much used in steam cylinders.

The fourth chapter is on Water Valves and Seats, and is illustrated by 49 engravings of different types of valves, and their construction and operation is fully described.

The other chapters are on Air and Vacuum Chambers; Suction and Delivery-Pipes; Water-end Design; Hydraulic Pressure Pumps; Steam and Power Crank Pumps; Direct Acting Steam Pumps; The Duplex Pump; Compound Direct-Acting Steam Pumps; Fire Pumps; Rotary Pumps; Centrifugal Pumps; Duty Trials of Pumping Engines; High Duty Pumping Engines—Direct-Acting and High Duty Pumping Engines—Fly Wheel.

With the exception of a few elucidations and demonstrations, there is no considerable use of mathematics. It is to be regretted that the author did not reduce all of these to arithmetical demonstrations or rules. With the exception of these mathematical parts—of which there are not many—the book can be easily read and understood by a mechanic whose education has not been extended beyond the three R's.

The book can be highly commended to all who want to increase their knowledge of the class of machinery to which it relates, and which is now so extensively used in all departments of the mechanic arts.

AMERICAN RAILROADS AS INVESTMENTS. *A Handbook for Investors in American Railroad Securities.* By S. F. Van Oss. (817 pp., 5¼ × 8¼ in.) New York: G. P. Putnam's Sons.

The subjects treated in this book are somewhat outside of those to the discussion of which the AMERICAN ENGINEER AND RAILROAD JOURNAL is devoted, and therefore it will only be described in a general way, but not reviewed.

Part I, the author says, "speaks of the rise of that unique conglomeration of lines which represents a nominal investment of upward of $10,000,000,000, and of its relations to the people and their government; Part II describes the position American railroads take in trade and travel, and discusses competition, rates, technical features, etc.; Part III sees the railroads in the light of financial ventures, of mediums for the useful employment of capital. . . . Parts IV to IX, inclusive, deal with the six leading groups of railroads. Each of them begins with a chapter describing an entire group and speaking of its characteristics as well as of the States it centers in, and further contains chapters devoted to the principal companies, while minor corporations are dealt with collectively. There are 39 chapters treating of 45 leading railroad companies, each giving an historical retrospect, a geographical description, a sketch of the progress and condition of the company, and elaborate tables covering a series of years and showing the development of the system, its traffic and earnings, as well as its capitalization, dividends, etc. Five colored maps are included in the volume; they illustrate the situation of every system and the competition to which it is exposed."

The author is a foreigner, and studied our railroad system at an angle of vision which is necessarily more or less indirect. Nevertheless he has studied our different railroad systems very carefully, and has brought together much valuable information and in a form that is easily understood. Chapter XXXIII, relating to the Chicago, Burlington & Quincy Railroad, may be taken as an example of his method. It begins with the date of the charter of the company, then describes the location of the road and extent and character of its traffic. This is followed by some remarks showing the competition which it must meet, the methods adopted to meet it, and the general condition of the property. After this tables are given showing the traffic, earnings, and expenses, balance sheet, and amount of capital stock, bonded debt, investments, etc., cost of construction, branch roads, and of uncanceled securities held in sinking funds. The chapter concludes with a statement of the

dividends paid from 1873 to 1892, beginning with 10 per cent. and gradually tapering down to 4¼ per cent. last year.

Similar sketches of other lines of road—some longer and others shorter than this—are given, from which a tolerably good idea may be obtained of the past and present condition of the properties.

The maps are excellent, and we know of no other publication from which so good an idea may be obtained of the various systems of road in this country.

The book is printed in a sort of condensed pica type not often used in this country, but which is clear and easily read. One mechanical defect, which is very common in the books of the Messrs. Putnam and other publishers, is the small margin on the inside of the page. It is ample on the outside, where it is not of much importance. Reading from a sort of crevice in the middle of a book is very annoying. In the words of Herbert Spencer, "whatever [intellectual] force is absorbed by the machine is deducted from the result. A reader has at each moment but a limited amount of mental power available." If this, or part of it, is absorbed in the effort to decipher print where it cannot be easily seen, there is so much less remaining for the comprehension of the contained idea. The book before us would be very much improved if the type was placed ⅛ in. nearer the outside margins.

Municipal Improvements. *A Manual of the Methods, Utility and Cost of Public Improvements for the Municipal Officers.* By W. F. Goodhue, C.E. (129 pp., 5 × 7¼ in.) New York: John Wiley & Sons.

There are people and books which we instinctively like on first acquaintance. The subject of this notice is a volume of that kind. There is nothing very attractive about its appearance, but after reading only a few pages the sound good sense which it contains at once captures the reader. We can't resist a quotation from the preface, in which the author says: "Once in every year throughout our broad land there are chosen, from among the citizens of every city and town, a number of councillors who will sit in the council chamber and assist the chief magistrate in the government of the municipality which they represent. The members of the council are perhaps familiar with the general plan and scope of the various public improvements contemplated during their administration, but of the details of the work proposed they are uninformed. It is in the nature of things that this should be so; their education and training have been in other work and its rewards. Yet, being men of affairs, they will not hesitate to seek such information regarding any proposed improvements as will enable them to discharge their official duties in a manner that will be commended by their constituents."

The Author does not say so, but his book is evidently intended for this class of people. It relates to sewerage, its cost and ventilation, the location of street-car lines, street sprinkling, street grades, surface, and pavements, street lighting and gas consumption, water works, municipal franchises, paving, bridges, assessments, fire limits, building laws and ordinances, building construction, the issue of municipal bonds, culverts, plans for a city hall, cleanliness, and public health. All these subjects are treated very briefly, but with admirable good sense.

Probably none of our readers who has ever had anything to do with municipal government will fail to appreciate the following remarks about street grades:

"Perhaps," the author says, "there is no other municipal improvement that will raise a longer and louder blast of indignation from property owners than the grading of a street. When such a job is under way the alderman who began it most generally wishes before the work is finished that either himself or that particular street had never existed, while the vocabulary of names having reference to imbeciles and other persons with little or no minds is exhausted and poured upon the head of the city engineer."

The benefits which would result if a copy of this book could be placed in the hands of every town and city councilman or alderman in the country would be incalculable. Take as an example the following hints about municipal franchises, of which the author says:

"A city granting a franchise at the present time should do so conditionally, and the conditions held in view should be:

"A re-rating at stated intervals of prices paid for service rendered.

"The termination of the contract by purchase whenever desired, in a fair and equitable manner.

"Reserving the right to annul the contract when the service rendered is continuously inferior to the better service required.

"When a company seeks to obtain a franchise from a municipality, it does so because it is believed that the results of its operation will be remunerative, otherwise it would not be asked for, and this fact should be borne in mind, as it affords some idea of the value of the franchise asked for."

If a printed copy of these suggestions could be hung up in every council chamber in the land, it would result in a great saving to the public and prevent the granting of many wrongful privileges.

The book is full of useful hints with reference to all of the various kinds of municipal improvements treated of, and may be read with interest and profit by any one concerned in public affairs.

Classified Illustrated Catalogue of the Library Bureau. *A Handbook of Library and Office Fittings and Supplies.* Library Bureau, 277 Broadway, New York, 146 Franklin Street, Boston, 215 Madison Street, Chicago.

In the Railroad and Engineering Journal for September, 1891, an editorial was published describing the extemporized system of preserving memoranda and papers which the writer had used for a number of years, and which was found to be a great help and convenience in doing editorial work. Although at that time we had some intimation of the applicability of this system, yet we did not realize the extent to which it might be used. We have now before us a copy of the catalogue, whose title is given above, showing the uses to which this system has been put of late years. This contains 175 pages, and illustrates a large number of the appliances which are furnished by the Bureau for use in the catalogues of libraries and for a great variety of other purposes. In one place they describe the card catalogue as a "series of cards properly ruled for their special use, of exactly the same size, and standing on the edge in drawers, boxes, or trays. They may be arranged alphabetically on any plan, by subjects, numbers or dates. Blocks, guides, cards, devices to prevent drawers from spilling or cards from being misplaced, locks and label holders and various other ingenious and almost essential accessories are now used by all who know of them. The great feature which has caused librarians the world over to count the card catalogue as the greatest library invention is the ease of keeping it up to date and in perfect order. A new card can be put into place anywhere at any time. A single reference takes the place of search through pages of manuscript. It never becomes out of date or useless. Anything can be removed, if wished, by simply lifting out its card. The guard allows cards to be added or withdrawn by the proper person with the greatest ease, but prevent others from removing or confusing their order. The cards, being cut by special machinery to an exact size, are turned through the fingers with great rapidity in looking up any matter, and the guides enable one to open very near the exact place at sight, and every card has the name, number, or subject by which it is arranged written on the upper edge. From an author's catalogue it

has spread to an almost infinite application. Every list, record, index, etc., that is in a state of growth can be thus kept with great saving of labor. Business houses find it invaluable for lists of goods, customers, discounts, and the thousand growing records of commerce. Science adopts it even more widely, and its use is spreading with growing rapidity. Each item being on a separate card, the whole may be rearranged over and over by simply shuffling into the new order. There is no copying nor waste of labor. Its enormous advantages once learned from use of a perfect outfit, it is sure to be applied to new uses."

It is said further that "every one who handles large lists of addresses or keeps in convenient order miscellaneous facts knows the great difficulties involved. Libraries recognized the difficulty in their work years before the great and growing records of commerce invented the card index, and discarded blank books for their indexes. Until recently its use has been confined to them, but somehow, with the customary avidity of commercial life, business men caught the idea, and without the influence of active propagation have to a wide extent adopted it.

"All the features that make it 'the greatest library invention' apply equally to commercial lists. Blank-book indexes with the wisest planning are sure to fill up irregularly, and never give perfect alphabetical arrangement for any list in a state of growth, while the card index can be maintained in absolute arrangement without limit to number of entries.

"Savings banks substitute it for the cumbersome and often to be rewritten blank-book index of depositors, and for recording signatures and points of identification; large manufacturing concerns use it in cataloguing patterns, drawings, keeping costs, etc.; insurance companies, for policy-holders' index and for statistics; railway systems, in keeping brief record of important points in their history, indexes to records, lists of employés; in fact, it is as great a labor saver to the business man as to the librarian."

One result of the great increase in the use of the card index by commercial houses has been the organization by the Bureau of a special department for writing, arranging and maintaining of indexes.

The Bureau not only undertakes this work, but sends its corps of experts to any locality, under the guarantee that the indexing will be done at less cost, more accurately, and the change from blank books to cards made without interruption of daily routine duties; in other words, a bank, municipal office, life or title insurance company, or any business house, may order its card index with no greater responsibility for results than in selecting and buying a desk or other office appliance, except to give the Bureau agent access to its records.

The special use to which we have put this system is in the care and classification of scraps, notes, and references. These may be most conveniently enclosed in envelopes, and the outside of them may be used for memoranda as conveniently as a card.

The Library Bureau now supplies all kinds of furniture, blanks, and supplies for keeping card catalogues of various kinds. These are made in a great variety of forms and sizes, and suited for all purposes. The increase of literature and knowledge of all kinds will make complete indexing much more essential in the future than it has been in the past. Without it our stores of knowledge will be useless, because they will be inaccessible.

BOOKS RECEIVED.

Hand-book of the American Republics, 1893. Bureau of the American Republics, Washington, D. C.

Description of the Lawrence Scientific School of Harvard University, Cambridge, Mass. Published by the University.

TRADE CATALOGUES.

NEW PROCESS BALLS, made by the Grant Anti-Friction Ball Company, Fitchburg, Mass., $3\frac{1}{4} \times 5\frac{1}{2}$ in., 8 pp. This little pamphlet is merely a brief advertisement of this Company, with a few letters commendatory of their products added. These latter are simply steel balls, which are made as nearly spherical as possible, and are then hardened. The title of the pamphlet leads one to hope that it contains more information than it does concerning the use to which such spheres have been put of late years.

CONSOLIDATED CAR-HEATING COMPANY, Albany, N. Y. Part XII., Electric Heater and Cable-Car Heating. $7 \times 10\frac{1}{4}$ in., 32 pp.

This company publishes its catalogues in parts. The one before us is on the subjects named. Their system of electric heating was very fully described in our last issue, so it need not be repeated here.

The latter part of the pamphlet is devoted to a description of the hot-water storage system of heating, which it is said is specially adapted for cable-cars, elevated railroad cars and other cars making runs of three hours or less. The system is adapted for heating any style of car where the runs are of such a character that a charging station can be passed once in about three hours, and a stop of one minute there be made for charging the heaters in the car. The distinctive feature of the system is water heat, stored in wrought iron pipes, conveniently placed in each car, and so connected that they can be charged with hot water under boiler pressure.

CATALOGUE OF THE ACME MACHINERY COMPANY, manufacturers of bolt heading, upsetting and forging machines, Cleveland, O., $6\frac{1}{2} \times 9\frac{1}{2}$ in., 32 pp. This is a special catalogue of bolt-heading and forging machines, which line of tools this Company has lately designed and now manufacture in connection with their Acme bolt-cutters and nut-tappers. The frontispiece is a wood-cut showing a perspective view of the works of this Company. This is followed by engravings and descriptions of 1 in., $1\frac{1}{4}$ in., 2 in., $2\frac{1}{4}$ in. and 3 in. heading and forging machines; the figures meaning that the different machines will make bolts, upsets and special forgings of iron up to these diameters. These illustrations are followed by sectional views and descriptions of the construction and operation of these machines. Candor compels us to say that these can hardly be regarded as models of clearness. They show how rare it is to find a person who is thoroughly familiar with a subject who can place himself in the attitude of mind which a person who knows nothing about it occupies, and can then write so that the latter can understand what he is writing about. The author of the pamphlet before us is no doubt thoroughly acquainted with the class of machinery about which he was writing, but he has not, it is thought, made proper allowance for the ignorance and stupidity it may be —of those of us who are readers of what he has written, but who are not experts.

The description of the machines is followed by a half-tone engraving showing the different kinds of work which has been done on these machines which is very interesting, and shows the range, so to speak, of the machines.

The volume closes with some interesting tables showing the amount of stock required to make square and hexagon bolt-heads, of manufacturers and United States standard sizes.

ILLUSTRATED CATALOGUE, BERRY & ORTON COMPANY, Atlantic Works, Philadelphia.

There seems to be something about the business of making wood-working machinery which requires very elaborate catalogues. At any rate, there is no class of manufacturers who

publish such elaborate books to describe what they make as the makers of this class of machinery issue.

The book before us is 10½ × 7 in. in size, and contains 263 pages. The frontispiece is a wood-cut showing the works of this Company, which are on the corner of Twenty-third and Arch Streets in Philadelphia. This is followed by an introductory article, direction to correspondents, and report of the awards made to them by the United States Centennial Commission in 1876.

The catalogue itself begins with planing machines, of which there are 27 engravings and descriptions of different kinds made by this company. There are six different kinds of moulding machines, a panel raiser, several kinds of wood-workers, with two pages of diagrams showing the manner of operating these machines. There are 34 engravings of different kinds of circular-saw machines, and two of scroll saws, nine of band-saw machines. Fourteen pages and 17 engravings are devoted to band saws themselves and the tools and machines for keeping them in good order. There are nine engravings of mortising machines, six of tenoning machines, 12 of boring machines, a "gaining and crozing" machine, two cross-gaining and grooving machines, four moulding and shaping machines, five lathes, two sand-papering machines, five sash and blind machines, besides a number of miscellaneous machines, such as knife grinders, glue heaters, metal drilling and sawing machines, pulleys, etc.

The catalogue indicates the extent and variety of the business in which this Company is engaged.

From the same Company we have also received their 1893 CATALOGUES AND PRICE-LISTS (3¾ × 5¾ in.), which has been thoroughly revised and rewritten, and contains 306 pages, 58 more than the preceding one.

ARMINGTON & SIMS ENGINE COMPANY, Providence, R. I., Catalogue of High-Speed Engines. 7 × 10 in., 47 pp. A novelty in this catalogue is an etching made from a photograph of the first high-speed engine which this firm connected directly to a dynamo. It is printed on buff paper and forms the frontispiece of the book. It is doubtful whether this kind of art can represent the sharp, clear and distinct effects so essential in representations of machinery as successfully as wood-engraving, which is as good as that on page 12 does, which was done by the John Andrew & Son Company.

The catalogue before us, after some preliminary remarks, gives a general description of the Armington & Sims high-speed engines. Its construction is shown by some excellent wood-engravings, and its operation is then elucidated by copies of indicator cards. An engraving on p. 12, already referred to, is one of the best examples of the wood-engraver's art, and represents a standard, single-cylinder, double-disk, self-contained, cut-off engine. Tables of sizes and indicated horse powers of this type of engines follow. A smaller engraving of a similar engine, but with a single disk and single wheel, with tables corresponding to those referred to for this type of engine is also given. These are succeeded by excellent engravings of the firm's cross-compound engines, with double disk, two wheels and self-contained, and tables of data relating to this type. A half dozen of engravings, made in white lines cut in a black background, represent different classes of vertical compound engines, and remind one of his early efforts at drawing on a slate. If we compare these with the engravings of a similar engine on p. 35, one is impressed with the feeling that the intagliated engravings are or should be an obsolete art. Excellent engravings of a tandem compound engine are given on pp. 32 and 33, and of some special engines on pp. 44 and 45.

The catalogue is beautifully printed on coated paper, and has an orange-colored rough paper cover, about the color of that of the AMERICAN ENGINEER. The coated paper is beautiful to look upon and gives excellent typographic results, but, to paraphrase the old conundrum, it's like music—it-s-mell odious. This tepid joke is applicable not to this catalogue especially, but to all which are printed on this kind of paper.

THE STANDARD STEEL WORKS, 220 South Fourth Street, Philadelphia. 7¼ × 10¼ in., 68 pp.

In the preface to their new catalogue, a copy of which is before us, this Company say they "desire to put before you graphically two important steps which it has recently taken:

"*First.* A complete change in the form of the ingots from which 'STANDARD' tires are made, insuring clean, solid steel, free from piping or porosity, such as is liable to occur in tires made in the old way.

"*Second.* The addition to its tire plant of the hammers, presses, dies and machine tools necessary for the manufacture, in the best possible manner, and in large numbers of the VAUCLAIN WROUGHT-IRON WHEEL CENTER for engine truck, tender truck, and coach wheels."

The first "step" they illustrate by some half-tone engravings showing the form and size of ingots which they formerly used under their old practice, and that which they are now using. The first were cylindrical in shape, with a diameter of from 12 to 18 in., and from 12 to 15 in. long. The ingots which they are now using have a hexagon-formed section of from 12 to 20 in. diameter and about 5½ ft. long. In another plate is shown one of the short cylindrical ingots and one of the long hexagonal cut longitudinally through their axes. This shows that each ingot has a honeycombed texture on top—they are both cast with their axes vertical—the longer ingot, as might be expected, having more of this spongy character than the short one. When the short ingots were used the porous part of it was hammered down and rolled into and formed part of the tire. To make their present method of manufacture clear, let it be supposed that the long ingot is divided into seven equal divisions in the direction of its length, and that it is then cut transversely at the first, third and fifth divisions. We would then have four pieces similar to the following:

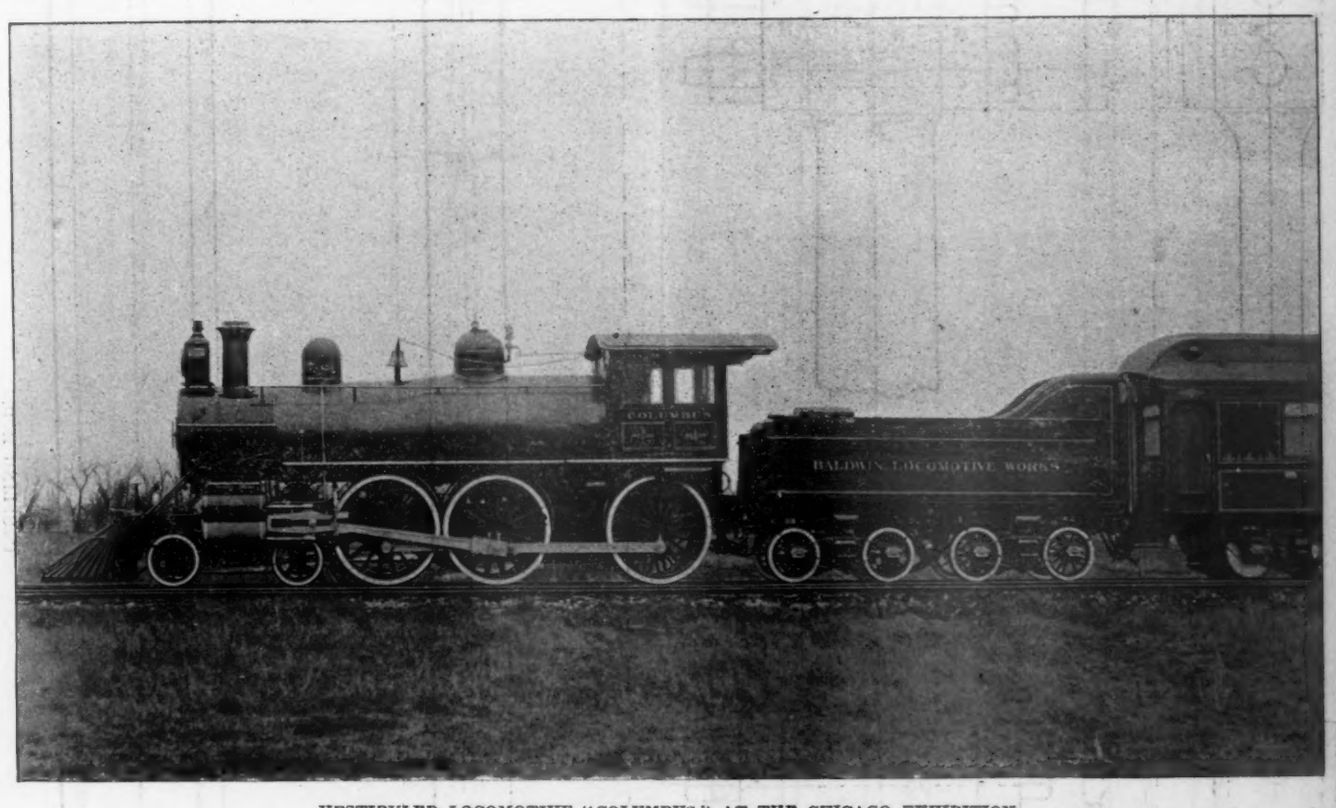
that is, there will be three billets each 18 or 19 in. long, and one short one of about half that length. The latter is cut from the top end of the ingot, and includes all the "piped" or porous metal in the ingot. This latter is thrown aside and scrapped instead of forming part of a tire, as it does when short ingots are used. The other three ingots will then consist of solid steel. The engraving showing longitudinal sections of a long and of a short ingot show the "piping" at their upper ends very distinctly. Another section shows the texture of one of the long billets into which the ingot is divided. Two other sectional views of tires whose grain has been developed by acid are given, one of them made from the old short ingots, and the other from one of the new billets. The difference in the homogeneity of the metal is very marked, and shows very much to the advantage of the new process.

The dissertation on tires is followed by a description of the Vauclain wrought-iron wheels and the method of manufacturing them. Half-tone engravings of the wheels, in different stages of manufacture and of their various parts, are given, and also outline engravings, made correctly to a scale, with all the principal dimensions marked on them, are added, for which many a draftsman will rise up and call the person who compiled the volume before us blessed.

Some excellent half-tone engravings showing exterior and interior views of the Standard Steel Works at Burnham, Mifflin County, Pa., are given in this catalogue, which is one of the best specimens of its kind. The printing, paper, press-work and binding are all very good.

COMPOUND LOCOMOTIVE WITH VESTIBULED TENDER.

We illustrate a ten-wheeled compound locomotive, *Columbus*, that is attached to the Pullman train exhibited at the World's Fair. This vestibule is for the double purpose of preventing the train over-riding or telescoping the tender in case of collision, and to prevent access to the train by train robbers should they succeed in stopping it. As to the first of these points the Pullman Company say that their experience has shown that the vestibule has practically eliminated telescoping from the results attending accident by collision or derailment, and that since its introduction the majority of accidents have arisen from the comparatively insecure connection between the tender and the train, there being nothing to prevent the front car from over-riding the tender. In our next issue we expect to give detailed illustrations of the tender and the vestibule.



VESTIBULED LOCOMOTIVE "COLUMBUS," AT THE CHICAGO EXHIBITION.

AMERICAN AND ENGLISH LOCOMOTIVES.

(*Continued from page* 268.)

Our illustrations of the various organs of the American and English express locomotives, which have been described in this series of articles, show the main connecting and coupling-rods of the two engines.

The following are the specifications of these parts for the Schenectady engine:

RODS.

Connecting and parallel rods of the best hammered iron, each forged solid, fitted with all necessary straps, keys, bolts, and Ajax metal brasses.

Parallel rods with solid ends, channeled bodies.

The English specifications are as follows:

CONNECTING-RODS.

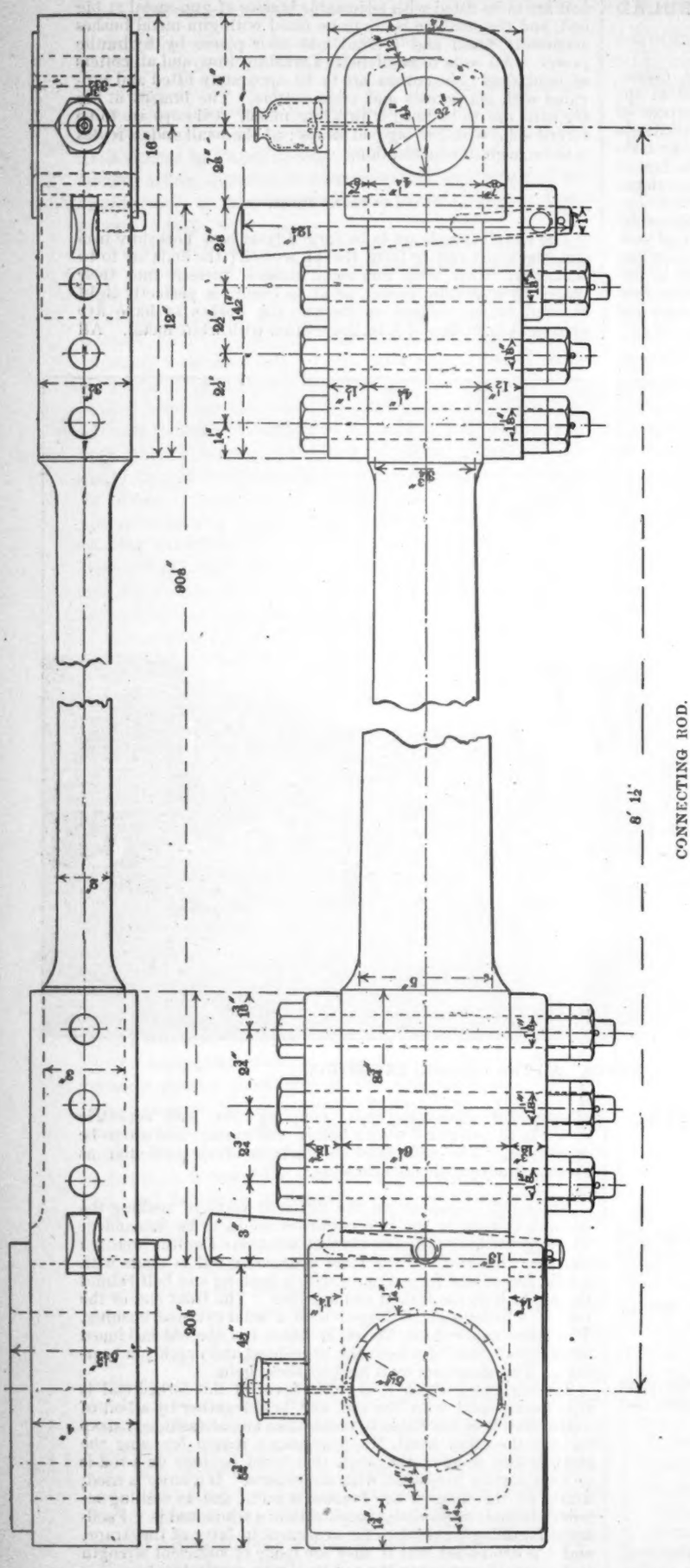
The connecting-rods are to be of the best Yorkshire iron, forged solid in one length, 6 ft. 8 in. from center to center, and are to be fitted with adjustable brasses of gun-metal at big end, and the small ends are to be fitted with gun-metal bushes accurately fitted and pressed into their places by hydraulic power. All bolts to be of best Yorkshire iron, and all cotters of mild steel; the cotters are to be accurately fitted and provided with set screws and cross cotters. The brasses at the big ends are to be lined with white metal. Oil-cups are to be forged solid with the big end straps; at the small ends a recess is to be made for lubrication.

COUPLING-RODS.

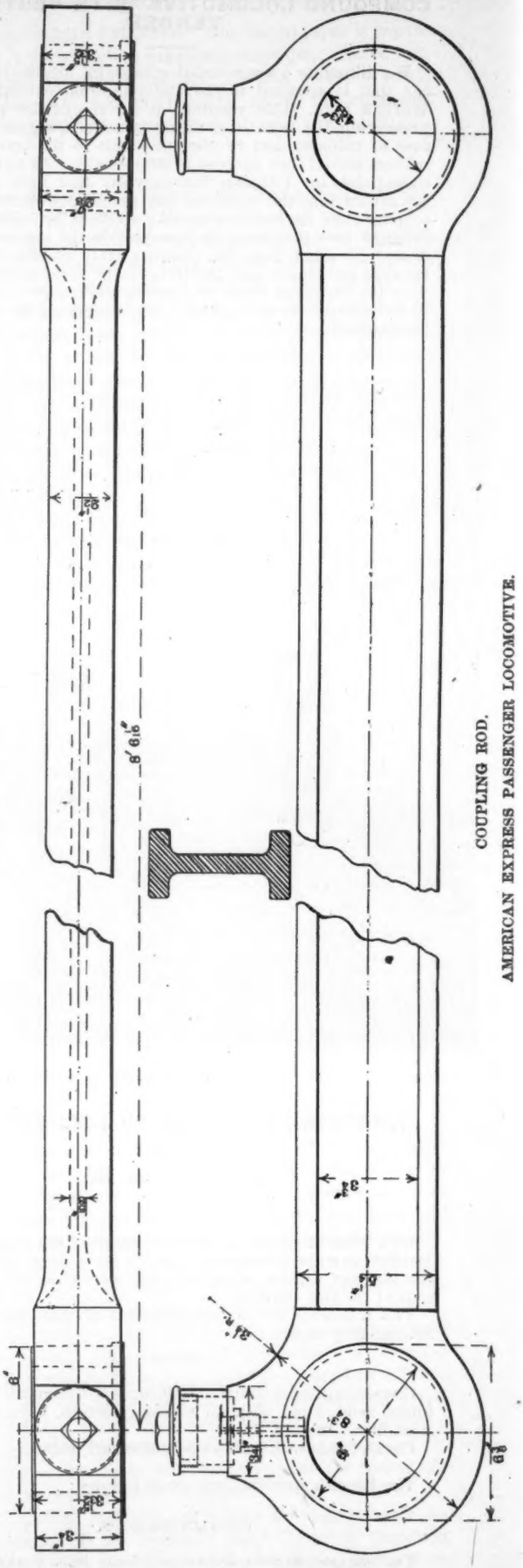
The coupling-rods are to be forged from best Yorkshire iron and machined out to form the H section; the ends are to be accurately fitted with gun metal bushes, pressed into their places by hydraulic power, so as to ensure a perfectly tight fit, and to be secured as shown; the bushes to have five grooves, $\frac{1}{4}$ in. wide and $\frac{3}{16}$ in. deep, fitted with white metal. All oil-cups for connecting-rods, coupling-rods, and eccentric straps to be provided with a button and spring, and are to be duplicates. The rods must be made in every particular as shown clearly on detailed drawing.

Not much comment on the different ways of making the connecting-rods in the two countries seems to be demanded. The only striking difference is that what our English brethren call the "big end" of the main connecting-rod is made with a solid forked end forged on it, with a bushing and bolt behind the pin to hold the forked end together. The front end of the rod, it will be seen, is forged with a solid eye and bushing. The American rod, on the other hand, has the old-fashioned strap "stub ends" for both the cross-head and crank-pin bearings. The straps are each held by these bolts.

The argument which is urged in favor of the forked end is that, being solid with the rod, and held together by a bolt of ample size, it is less liable to break than an old-fashioned strap is. On the other hand, Mr. Buchanan's reason for using the strap is that most of the work that must be done on a rod is on that portion in contact with the brasses. If a strap is used, nearly all the wear of the brasses is on it, and in making repairs a strap is much easier handled than a whole rod is. Facility of handling is therefore the argument in favor of the straps, and it is contended that if they are made of sufficient strength and properly secured to the rod they very rarely break.

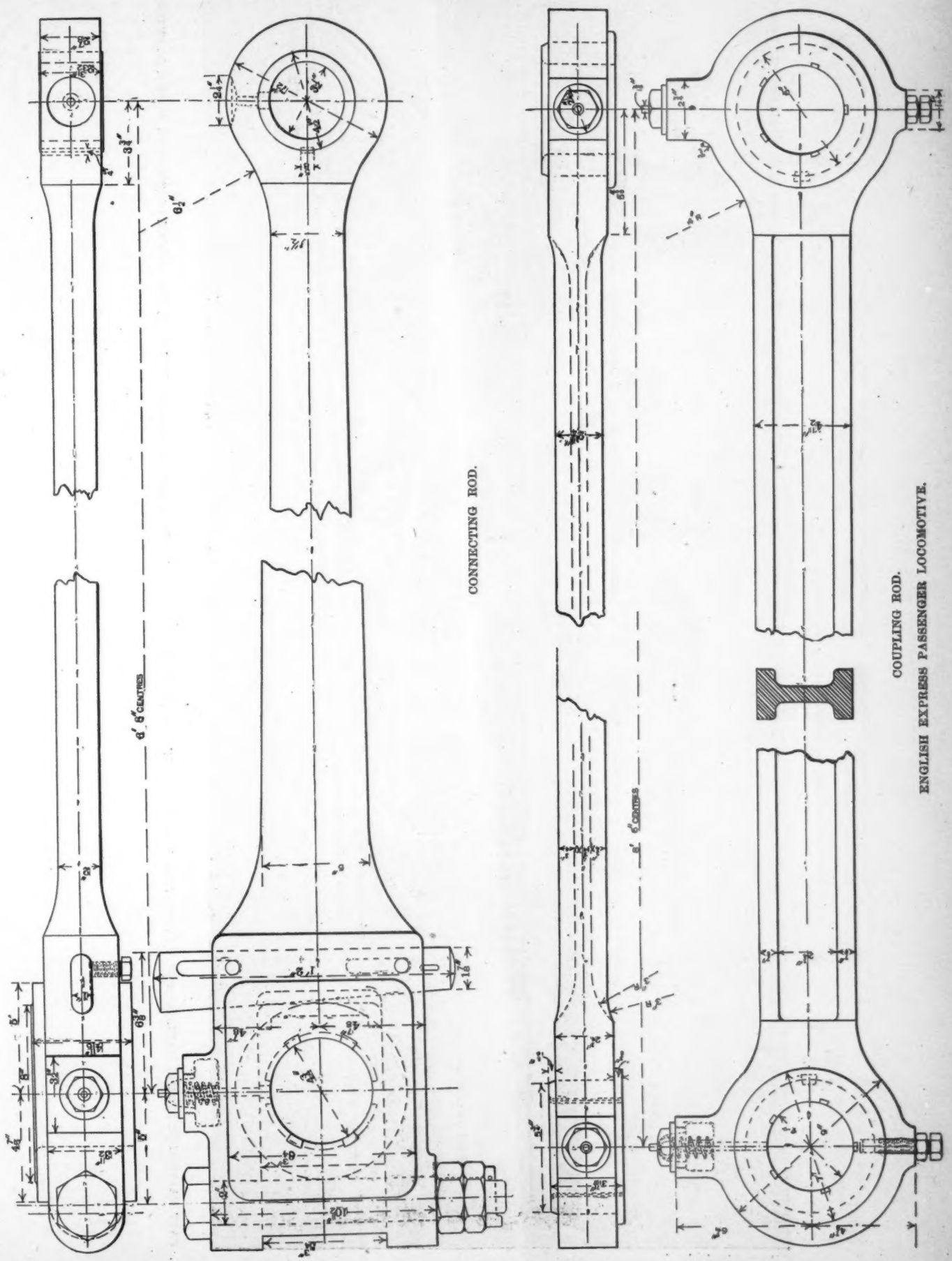


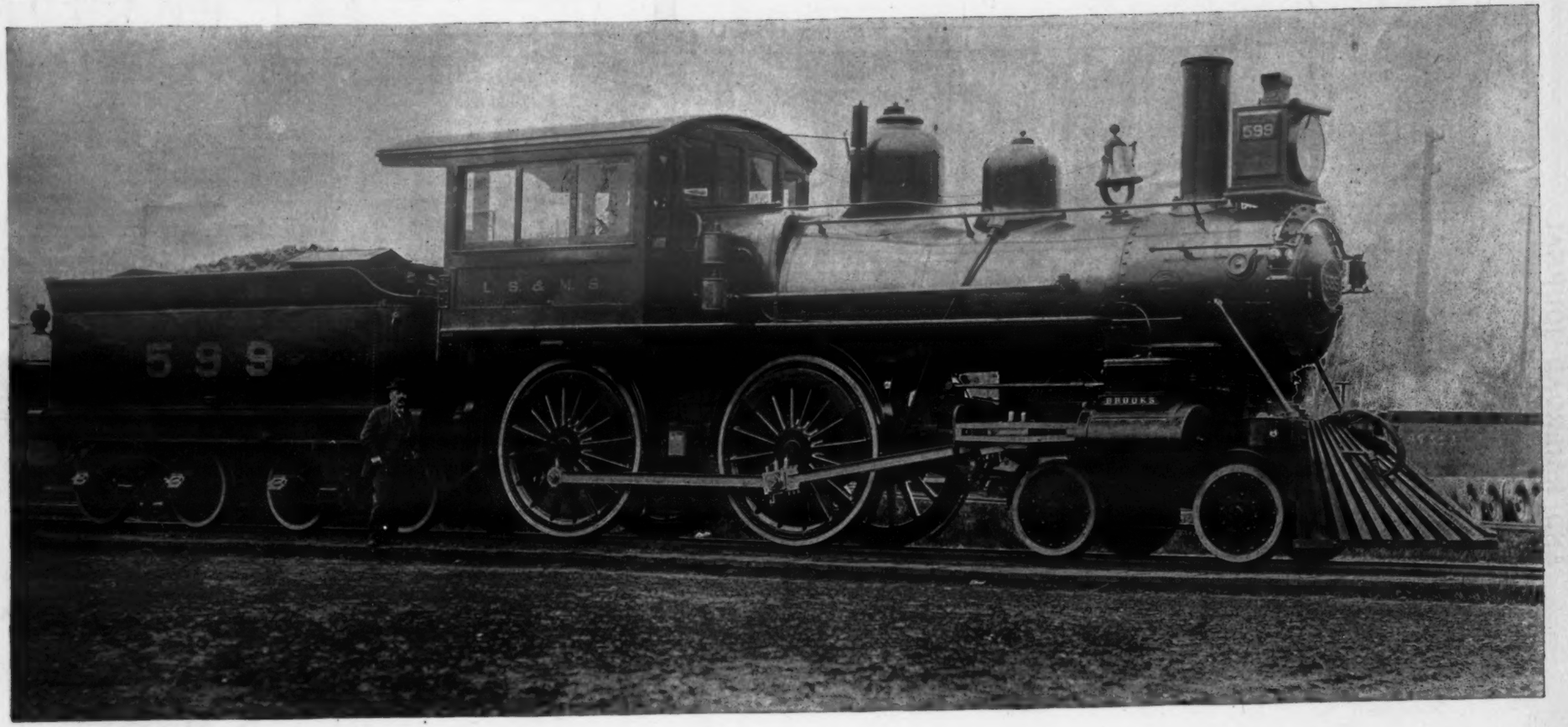
CONNECTING ROD.



COUPLING ROD.

AMERICAN EXPRESS PASSENGER LOCOMOTIVE.


6' 6" CENTRES
CONNECTING ROD.
6' 6" CENTRES
COUPLING ROD.
ENGLISH EXPRESS PASSENGER LOCOMOTIVE.



FAST PASSENGER ENGINE HAULING THE "EXPOSITION FLYER" ON THE LAKE SHORE & MICHIGAN SOUTHERN RAILWAY. BUILT BY THE BROOKS LOCOMOTIVE WORKS, DUNKIRK, N. Y.

It is due to the Schenectady Locomotive Works to say that they make both kinds of rods, but Mr. Buchanan prefers the type which we have illustrated.

It will be seen that the size of the crank-pin bearing for the main connecting-rod on the American engine is $5\frac{1}{2} \times 5\frac{1}{2}$ in., while that of the English engine is only $4\frac{1}{4} \times 4\frac{1}{2}$ in. The diameter of the cross-head bearings is the same on both engines, but that on the New York Central engine is an inch longer than on Mr. Adams's machine.

The coupling-rod bearings are of the same length on each engine, but those on the American machine are $4\frac{1}{2}$ instead of 4 in. diameter, as on the English engine.

It will thus be seen, that although the cylinders of the English engine have 2 in. more stroke than those of the Yankee locomotive, the latter has considerably larger bearings for its connecting-rods. The English bushings for the coupling-rods are, however, 1 in. thick instead of $\frac{3}{4}$ in., as on the American rods. By comparing the dimensions of the two coupling-rods, it will be seen that the American rod is considerably heavier between its two ends than the English rod. It would be interesting to know whether any trouble has been experienced from the breaking of the lighter rods.

The oil-cups are all forged solid on the rods. Probably the same experience, of detached oil-cups, has led to this uniformity of practice.

FAST PASSENGER ENGINE FOR THE LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

THROUGH the courtesy of the Brooks Locomotive Works, builders of the engine, we are enabled to present a full-page perspective illustration of the fast eight-wheeled express passenger locomotive which is now in use on the Lake Shore & Michigan Southern Railway, for hauling the Exposition Express over that line, and which is now making the trip from New York to Chicago in 20 hours, referred to in another column of this issue.

The general appearance of the engine is very clearly shown by our perspective engraving, and the peculiar feature to which we desire to draw especial attention is the boiler, of which we give a detailed engraving. This is of the Belpaire type, and its general dimensions will be found in the specifications which follow.

The general dimensions of the engine are :

GENERAL DESCRIPTION.

Cylinders, 17" diameter, 24" stroke; driving wheels, 72" diameter; gauge, 4' 8½"; fuel, bituminous coal; rigid driving wheel base, 9'; total wheel base of engine, 23' 9"; total wheel base of engine and tender, 45' 8".

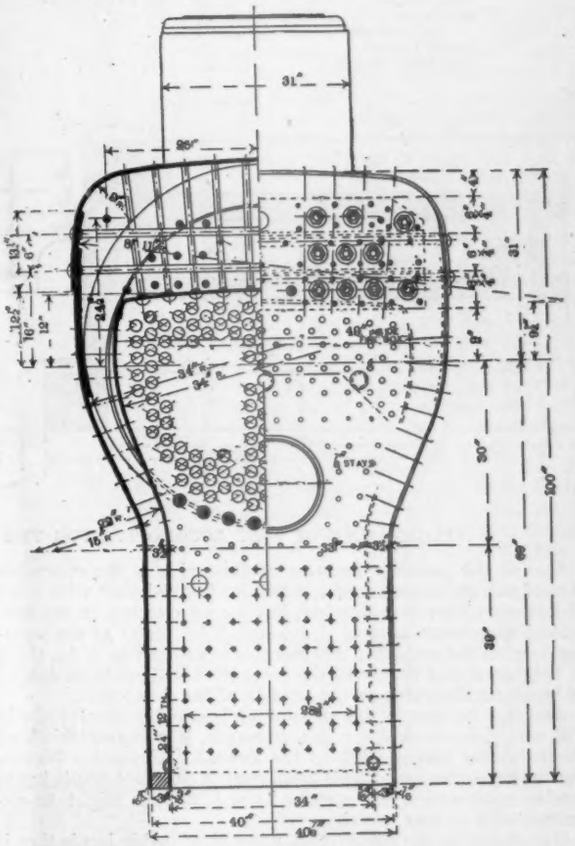
Weight of engine in working order	104,600 lbs.
" " " on engine truck	39,500 "
" " " " main drivers	33,100 "
" " " " back "	32,000 "
" " tender loaded	70,000 "

BOILER.

Type	Improved wagon top Belpaire with conical connection; dome on connection sheet.
Working pressure	180 lbs.
Material	Steel, $\frac{5}{16}$", $\frac{3}{8}$", $\frac{1}{2}$", and $\frac{7}{16}$".
Riveting	Longitudinal seams, quadruple lap, without welt.
"	Circumferential seams, double lap.
Waist, diameter at smoke-box	52".
" " " throat sheet	60".
Tubes	200 in number, 2" diameter, charcoal iron.
"	Length, 12', No. 13 B. W. G.
Fire Box	78" x 34" inside ring.
" depth	81" at front end, 79" at back end.
" crown sheet	Arched, 1½" laterally in center.
Brick arch	Carried on three 2½" water tubes.
Heating surface	Fire box and arch pipes, 155 sq. feet.
" "	Tubes, 1,258 sq. feet.
" "	Total, 1,413 "
Safety vales	1 Richardson muffled and 1 Richardson plain.
Extension front	Deflector in front of exhaust pipe.
Stack	Cast-iron, straight, 16" diameter.
Exhaust pipe	High double.
Grates	Cast-iron rocking-bar.

MACHINERY.

Cylinders	17" x 24", 84" centers.
" packing	Dunbar.
Piston rod "	Jerome.
Valve stem "	"
Steam ports	1¾" x 16".
Bridges	1⅛".
Exhaust port	3" x 16".
Valves	Allen Richardson.
" Allen port	$\frac{1}{2}$" x 16".
Valve, lap outside	1".
" " inside	$\frac{3}{32}$".
" lead in full gear	$\frac{1}{4}$".
" travel, maximum	6⅛".
Eccentric travel	5".
Link radius	68".
" face	3".
" centres of eyes	13".
" block wearing face	5".
" " flanges	7¾" x 3½".
" saddle pin	1¾" x 6".
" rocker pins, top and bottom	1¾" x 4".
Link hanger centers	18½".
" lifter arms, length	20½".
Reversing lever, multiple latch	Player's patent.
" " throw on top	42".
Driving wheels, diameter	72".
" " centers, diameter	66".
" " tires, Midvale	With Mansell retaining rings.
Driving axles	Hammered iron.
" " journals	7½" x 9".
Connecting rods, hammered iron, fluted	Fitted with straps and keys.
Coupling rods, Midvale steel, fluted	Fitted with brass bushings.
Crank pins	Midvale steel.
" " main	4½" x 6".
" " " coupling	5" x 4".
" " " wheel fit	5" x 7".
" " back	3½" x 4".
" " " wheel fit	4" x 7".
Frames, 46", centers forged solid	3" x 4½".
Frame, back end dropped down 5" to accommodate standard tender.	



Frame, pedestal ties	Player's patent.
Engine truck, four-wheeled	Swivelling spherical centre.
" " wheels	33", Allen paper.
" " axles	Hammered iron.
" " " journals	5" x 10".
" " springs	Detroit.
Driving spring rigging	Equalized.
" " auxiliary	Under rear spring hangers.
" "	Detroit.
Lubricator, cylinder	No. 9 Nathan triple.
Feed water	Two No. 8 Monitor injectors.
Oil-cups, rods and eccentrics	Adjustable spindle feed.
" eccentrics	Fitted with swab cups top and bottom.
" guides, etc	Adjustable screw feed.
Cab	Ash.
Cab fitted with three windows on each side, front stationary, middle and back to slide.	
Pilot	Fitted with shackle bar.
Brakes, train and tender	Westinghouse.
" drivers	"
Train signal	"
Steam-heating apparatus	R. R. Co.'s standard.
Headlight	" " "
Classification and signal lamps	" " "

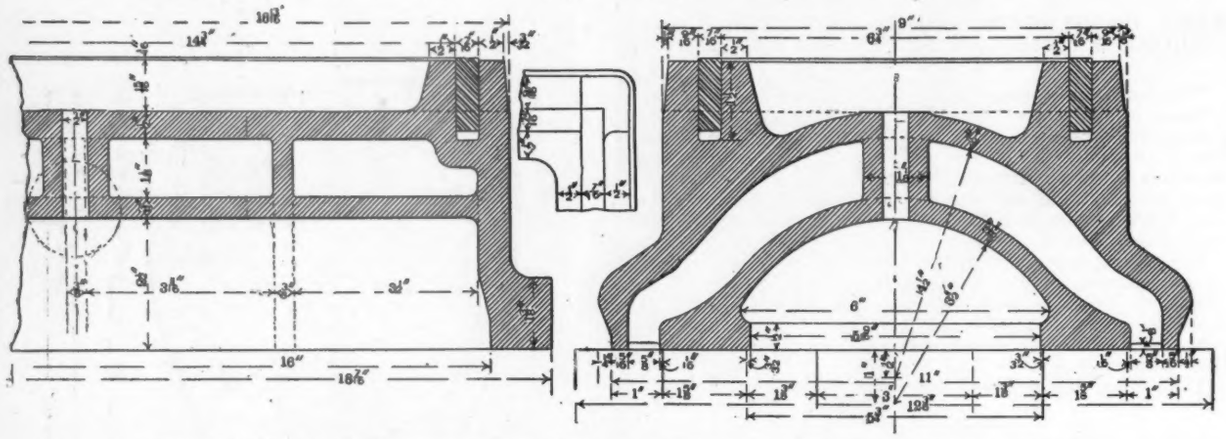
TENDER.

Frame	10" Channel steel.
Tank	and ¼" steel.

Tank capacity, water	3,100 galls.
" " coal	6 tons.
" water scoop	Improved Ramsbottom.
Tender trucks	Diamond pattern.
" " bolster	Steel I beam.
" " wheels	36" Allen paper.
" " axle	Hammered iron.
" " " journal	4" x 7".
" coupler and buffer	Gould.

We also give an illustration of the valve, the general dimensions of which are as follows :

Cylinders	17" x 24".
Boiler pressure	180 lbs.
Steam ports	1¾" x 16".
Bridges	1⅜".
Exhaust port	3" x 16".
Allen port in valve	⅝" x 16".
Valve travel in full gear	6¼".
" lap outside	1".
" " inside	⅜".
" " in full gear	1⅜".
Eccentric travel	5".
Distance from center of axle to center of rocker	70½".
Link radius	68".
" centers of eyes	13".
" block wearing face	3" x 5".
" distance between faces	2¼".
" block flanges	3¼" x 7⅛".
" saddle-pin	1¾" x 6".
" " off-set	⅝".
" hanger centers	18½".
" lifter arms, length	20½".



SLIDE-VALVE OF FAST LOCOMOTIVE FOR THE LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

One of the peculiar features of this valve is the enormous area of the Allen port used : it will be noticed that with a lap of 1 in. this port is ⅝ in. wide, having an overlap on the outside of the steam port of $\frac{1}{16}$ in. and $\frac{1}{16}$ in. metal at the wearing face on the outside ; this metal is reinforced to $\frac{5}{16}$ in. thick at a distance of ¼ in. above the face, so that there is no danger of breaking the valve on the outside of the Allen port.

Another feature is the amount of inside lap employed—in this case $\frac{3}{16}$ in. each side ; this, however, is a characteristic of all the Allen valves used by the Brooks Locomotive Works, and owing to the long travel employed, it does not result in excessive compression at the end of the stroke, as might be expected with shorter travel.

One object in the use of this amount of inside lap is that it permits the metal in the valve between the exhaust cavity and the Allen port to form a sufficient bearing upon the port face, thus preventing the hollowing out of the edges of the ports and edges of the valve, as is the case when Allen valves are constructed without having this additional bearing surface.

PATENALL'S IMPROVED SYKES' SYSTEM OF BLOCK SIGNALS.

By the Johnson Railroad Signal Company, Rahway, N. J.

(Copyrighted June, 1893.)

III.

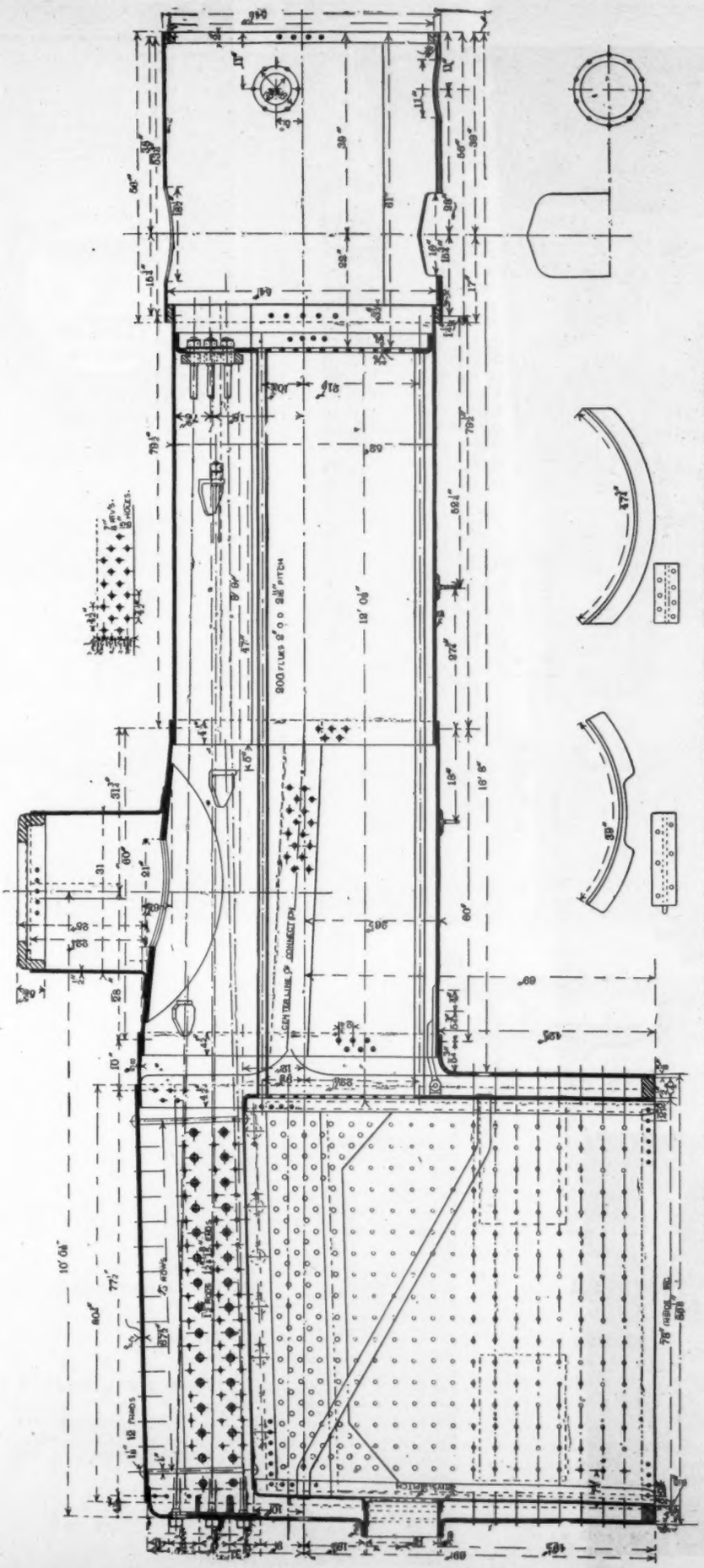
In the last number of this series of articles the general principles which are embodied in this system of signals was explained. In this one the mechanism in the indicator cases, by which the signals and the signalmen are controlled, will be described.

Fig. 20 represents a side view of the mechanism in one of the indicator cases, *R*, shown in figs. 5, 6, 7 and 9, published last month, and a section of the external wooden casing, *A A*, is shown in section in fig. 20. For convenience in representing some of the parts, they are shown as they appear in looking at the case from the opposite side from that in which it is shown in figs. 5 and 9. Fig. 25 is a similar view to fig. 20, but with some of the parts shown in different positions, as will be explained. Figs. 22 and 23 show views of some of the parts, which will also be explained later. Fig. 21 is a front view of the case, and shows its external parts. Fig. 26 is a transverse section of it, showing the internal parts.

A A, figs. 20 and 25, is the wooden casing of the instrument, which is of oblong rectangular form, as shown in the different views. Within the casing there is mounted a longitudinal sliding bar, *S' S*, the front end *S'* of which projects through the casing and is there provided with a latch, *S''*, which is hinged to the section *S'* at *b*, and is provided with an operating handle, *H*. The latch *S''* is also provided with a downwardly extending lip, *c*, adapted to engage with the lugs *a* and *a'* on the bracket *D* projecting from the front of the casing *A*, which thereby holds the bar *S' S* in the required longitudinal positions. A rocker *R* is pivotally connected at *d* to a support, *F*, at the bottom of the casing. A bearing, *e*, fig. 20, on the upwardly extending arm of this rocker is adapted to be engaged by a stud or pin, *e'*, on the side of the sliding bar, *S' S*, when the latter is drawn outward by the handle *H*. During this movement the stud *e'* comes in contact with the bearing, *e*, as shown in fig. 25, in which the bar is shown in the position it occupies when drawn out. This movement turns the rocker about its pivot, *d*. This has the effect of lifting the rod *C'*, which is connected at *f* to a horizontal projection on the rocker *R*. As the rod *C'* is connected with the dog, *k*, shown in fig. 10, published last month, it will be seen that the effect of pulling out the bar *S S'* is to unlock the latch of the lever, *L*, fig. 9, and make it possible for the signalman to throw it over and lower the signal. The upper portion of the rocker, *R*, figs. 20 and 25, is further provided with a straight bearing, *c'*, against which the stud *e'* will bear as the bar *S' S* is slid toward the right, and will thus return the rocker to its normal position, as shown in fig. 20, and thus by depressing the rod *C'* will again lock the lever *L*, fig. 9. It will be seen from fig. 20 that when the rocker has been moved so as to depress the rod *C'* that the stud *e'* is then free to slide horizontally above the straight bearing *c'* for a certain distance without moving the rocker. The object of this will be made apparent later on. It will be seen, though, that by pulling the handle *H* outward, and thus sliding the bar *S' S* in the same direction, the signalman unlocks the lever *L* of fig. 9, by which his own home signal is raised and lowered.

It remains to show how this operation of the signalman at any station is controlled by the man at the station ahead of him, the purpose of which provision has already been explained.

On its upper edge the bar, *S' S*, figs. 20 and 25, has an elongated notch, *b'*, and a shorter notch, *b''*. *M* is an electro magnet located above the bar *S' S*. Below this magnet a vibrating lever *G* is pivoted at *d'* to a suitable support *i*. This lever carries an armature, *f'*, which may be acted upon by the electro-magnet *M*. The lever *G* also has a pendent latch, *g*, pivoted to its outer end. This latch engages with the notches *b'* and *b''* whenever it is not held out of engagement therewith, either by the attraction of the magnet acting on the armature, *f'*, and thus raising the lever, or by being positively held up by a catch *k* on the lower end of *g'*. *g'* depends from a T-shaped lever, *h i' j g'*, which is pivotally connected to a suitable support at *i'*, and is counterbalanced by a weight *j*. The forwardly extending arm *h i'* of this lever is connected by a vertical rod, *h h'*, with an arm *a''* on the horizontal rock-shaft *K K* in the



BOILER OF FAST PASSENGER LOCOMOTIVE FOR THE LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

upper part of the casing. This arm is located at a'' in figs. 20 and 25, and is shown clearly in fig. 26. The shaft has an indicator plate B attached to its outer end. This indicator, and another on B', which will be referred to presently, occupy positions behind openings O and O' in an opaque plate, p' p', in the front of the casing. The indicators may be seen through these openings, as shown in fig. 21, and the indicating words or symbols may be read when the operating mechanism has been moved into the proper position to bring the indicating symbols into position. The plate p' p' is covered with a glass plate, G', through which the indicators may be seen.

The shaft K K is also provided with a counterweight, w, figs. 20 and 26, to counterbalance the indicator plate, B, and thus leave the shaft K free to be rocked by the movement of the lever h i'' j through the connecting-rod h h'. The counterbalancing of the lever h i'' j and shaft K K is so adjusted that the arm h i'' tends normally to fall under the influence of gravity, and thereby swing the catch k to the right. If the lever G is then lifted by the attraction of the magnet M, the catch k will engage under the end of the lever G, as shown in fig. 20, and hold the latch g out of engagement with the notches in the bar S' S until the lever h i'' has been raised and the catch k has thus been disengaged from G. Such movement of the lever h i'' is effected by an upwardly extended cam J attached to the bar S' S, and adapted to engage with a roller r', which is carried in bearings depending from the under side of the lever h i'' as the bar S' S is slid back and forth.

On the inside of the indicator casing a vertically sliding bar L L is held in position by bearings l l, see fig. 20, and is connected to the horizontally sliding bar S' S by a bell crank m n o'', shown by dotted lines in figs. 20 and 25. This bell crank has a fixed pivoted bearing at n, and is connected to a pin or stud, o, on the horizontal sliding bar S' S by an open-ended slot, and to another pin m on the vertical sliding bar L L by a similar connection. It will readily be seen that by means of this connection the horizontal sliding of the bar S will transmit a vertical movement to L L.

Near the top of the indicator case another vibrating lever r q s is pivoted to a suitable bearing or support at q, and is connected by a slotted end to a pin r on the vertically sliding bar L L. On its opposite end it has a forked end, s s', the form of which is shown clearly in fig. 23, which represents a plan or top view of this lever and contiguous parts. The end s s' consists of a pair of electrical circuit-making jaws, s and s', which are insulated from the arm r q s, but are electrically connected with each other by one or both of the fastening screws, s'' and s''. On the inside of the casing a contact plate P' is secured in such a position that, as the vertically sliding bar L L is lowered and carries with it the end r of the lever r q s, and raises its opposite end, s, the circuit-making jaw s is brought into contact with the surface of the plate P', which is shaded with horizontal lines. On the opposite side of P', and separated from it and from each other by insulating material i'' i'', fig. 23, are two

Fig. 20.

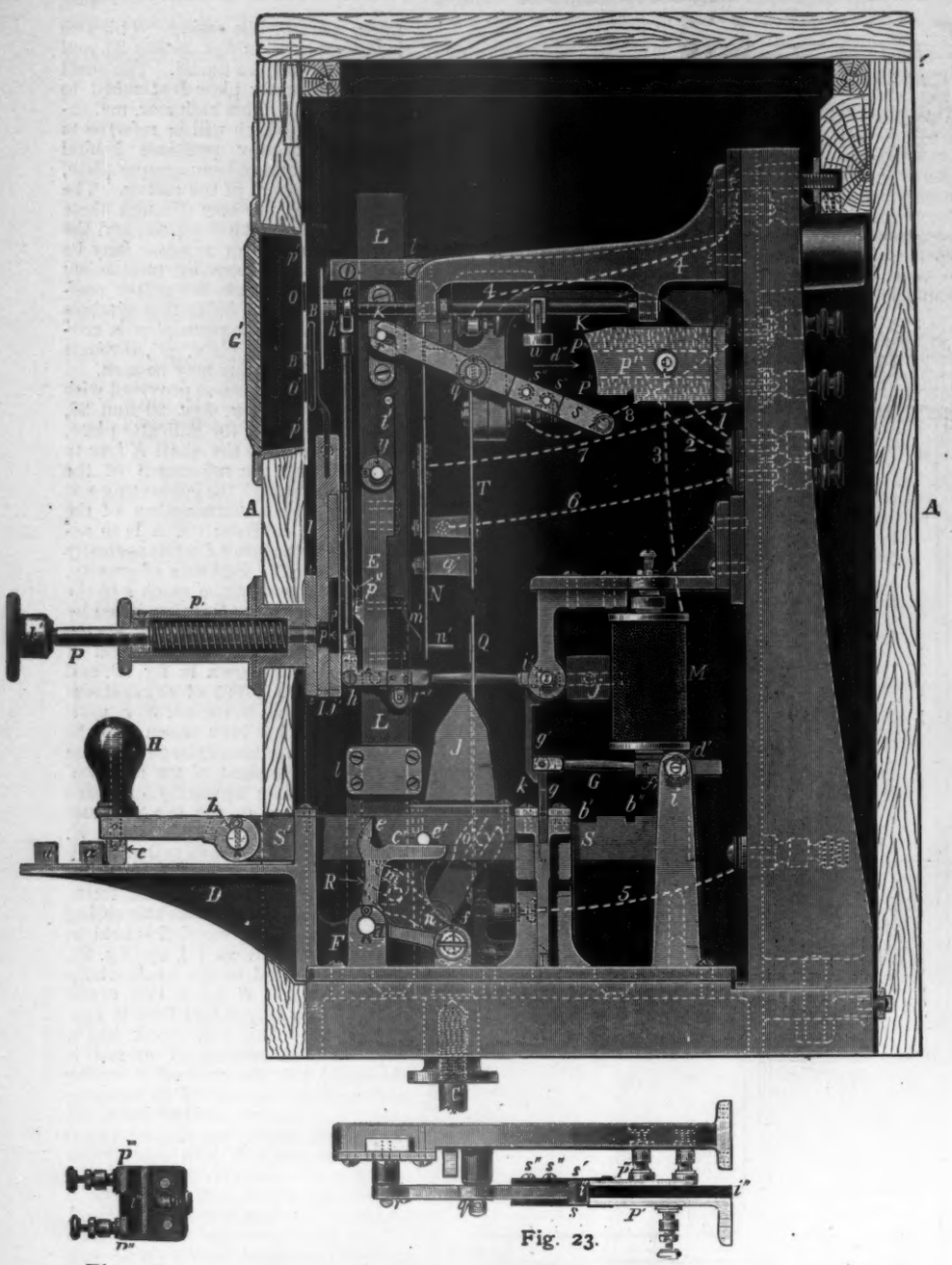


Fig. 21.

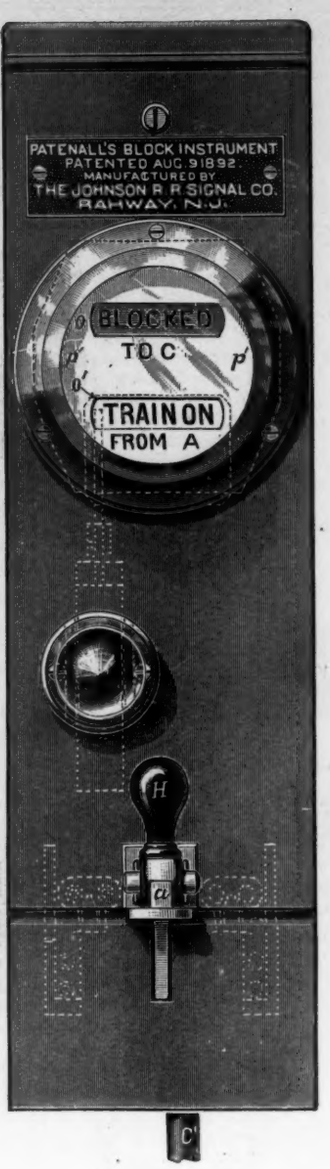


Fig. 22.

Fig. 23.

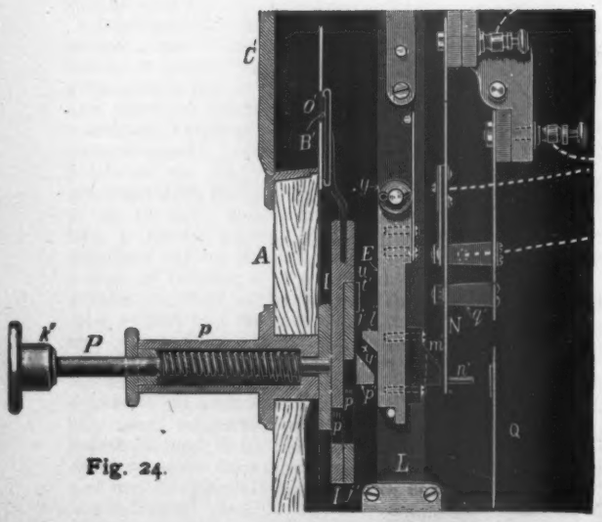


Fig. 24.

PATENALL'S BLOCK SIGNAL INSTRUMENT,

MANUFACTURED BY THE

JOHNSON RAILROAD SIGNAL COMPANY, RAHWAY, N. J.

Fig. 25.

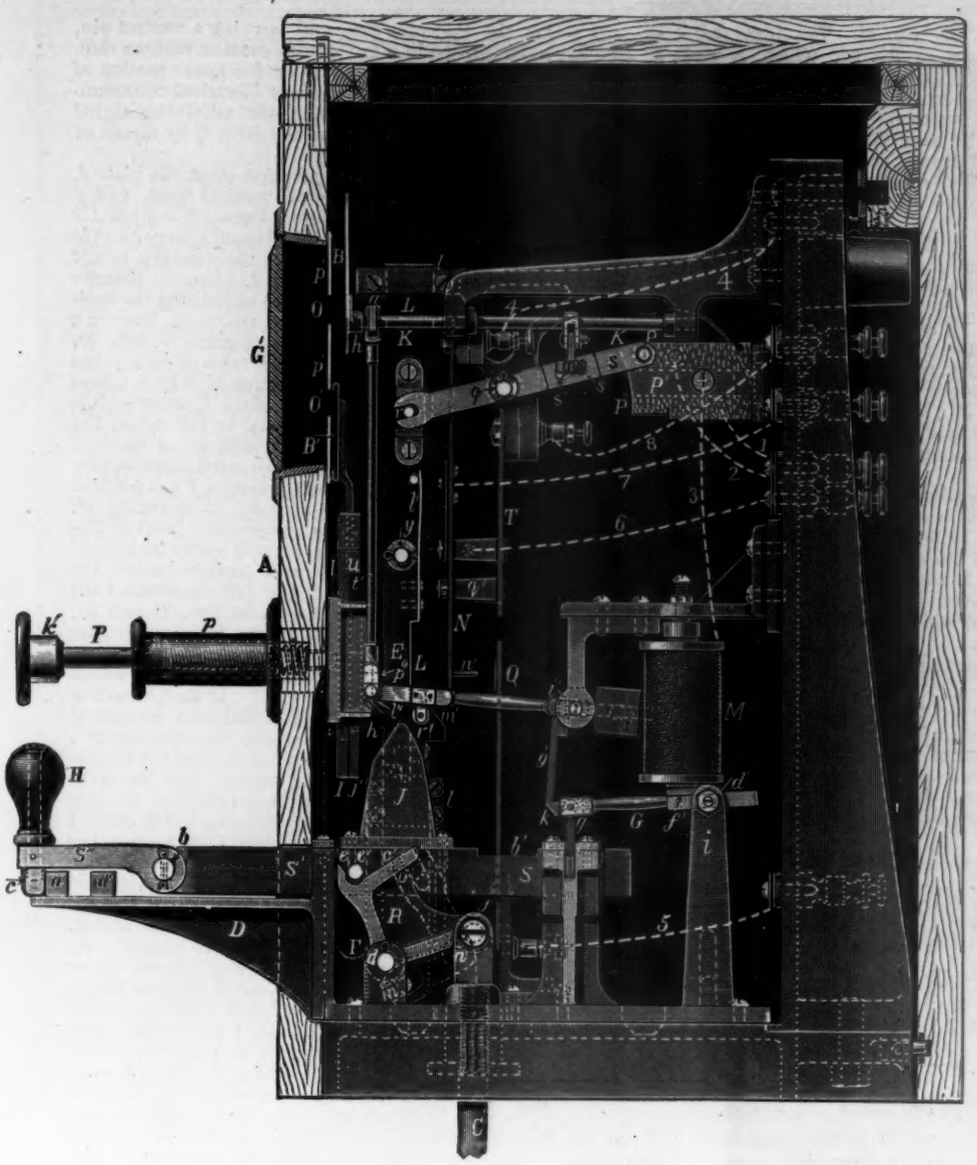
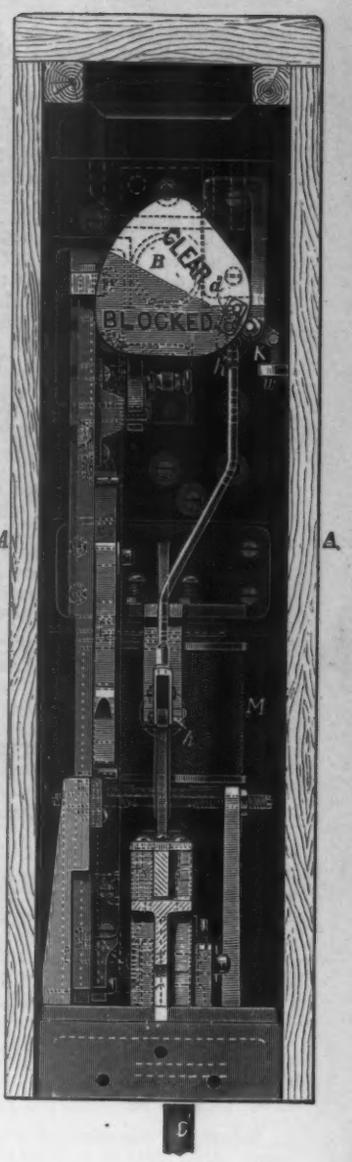


Fig. 26.



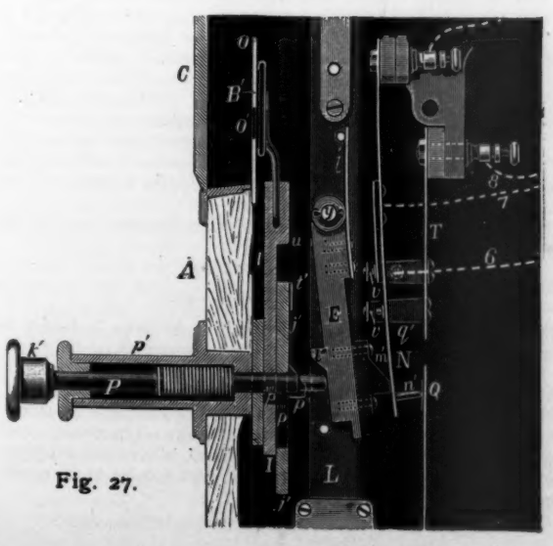


Fig. 27.

PATENALL'S BLOCK SIGNAL INSTRUMENT,

MANUFACTURED BY THE

JOHNSON RAILROAD SIGNAL COMPANY, RAHWAY, N. J

more contact plates, P' and P''', see fig. 20. The form and position of these plates is shown in fig. 22, which is an end view of them looking in the direction of the dart d'' in fig. 20. In figs. 20 and 25 the contours of these contact plates are indicated by dotted vertical lines. By reference to figs. 20 and 25 it will be seen that when the vertically sliding bar $L\ L$ is lowered from the position shown in fig. 20, and the circuit-making jaws s and s' are raised, that s will come in contact with the plate P' and at the same time that s' will come in contact with P''', which is on the opposite side or behind P', as it appears in figs. 20 and 25. As the circuit-making jaws are electrically connected together, the contact plates P' and P'' will then also be similarly connected. If the jaws are raised still higher, s will still remain in contact with P', but s' will swing past P'' and will no longer be in contact with it, and electrical communication between the two plates will then be broken. When the jaws have moved far enough, or into the position shown in fig. 25, s' will then come in contact with the plate P''', and s and s' will then be in simultaneous contact, the one with plate P' and the other with plate P''', and electrical communication will thereby be established between them.

The plate P' is in normal electrical communication by the wire 1 with the line-wire, which is connected with the next station ahead; the plate P''' is in permanent electrical communication by the wire 2 with a track treadle or circuit at the station where this instrument is located, and the plate P' is in permanent electrical communication by the wire 3 with the electro-magnet M for the purposes which will hereafter appear.

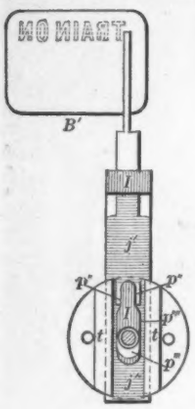


Fig. 28.

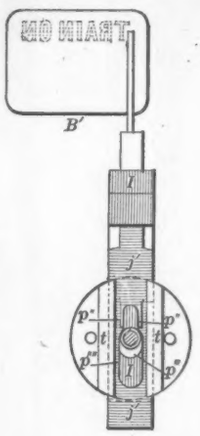


Fig. 29.

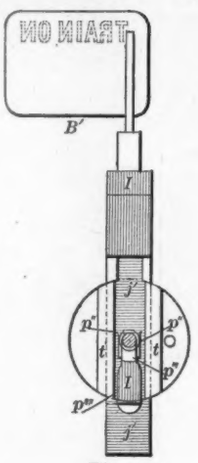


Fig. 30.

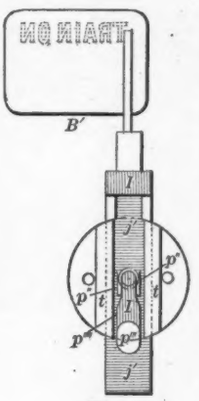


Fig. 31.

Before the operation of this instrument is fully explained, some other parts of its mechanism will be described.

The vertically sliding bar $L\ L$, figs. 20 and 25, carries a vibrating arm, E, which is pivoted to $L\ L$ at y. It is provided with a spring l', the tension of which tends to keep the arm normally swung toward the front of the indicator case. In front of each indicator case is what is called a "plunger," P, which is shown in section in fig. 20. It consists of a central rod or spindle P, which is housed in a cylindrical barrel, p, attached to the front of the indicator case. The outer end of the rod has a button or knob k' on it, by which it can conveniently be pushed inward. A helical spring is placed inside of the barrel, and bears against a shoulder on the rod or plunger, and thus tends to throw it outward to the limit of its movement. Within the casing and in the path of the plunger there is located a drop-plate, I, a back view of which, looking in the direction of the small dart on the right of p''', fig. 20, is shown in fig. 28, and which works in a slide, $t\ t$, attached to the inside of the case. To the upper portion of this drop-plate an indicator B', shown in figs. 20, 25, and 28, is attached. On its inside the drop-plate I carries a movable section, j', which can also move vertically in the slides $t\ t$ of fig. 28, so that it can fall a given distance independently of the plate I. The lower end of the vibrating arm E is located in the path of the plunger P, as shown in figs. 20 and 27, and is provided with a nose, l'', see fig. 24. The drop-plate j' is also provided with a nose, p'', corresponding to l'' and adapted to engage or interlock with it. Figs. 24 and 27 are views similar to figs. 20 and 25, but which show only the plunger, drop-plates, and contiguous parts, but in different positions from which they are shown in the complete figs. referred to last. The arm E is also provided with a block of insulating material, m', the nose of which is in position to engage a flexible electrical conducting strip, N, see figs. 20, 24, 25, and 27, depending from a suitable support within the indicator case, and carrying a contact pin, n', adapted to be thrown into and out of contact with an electrical conducting strip Q uprising from the lower portion of the casing. The strip N is in permanent electrical communication with the line-wire connecting the adjoining signal stations by means of the wire 4, and the strip Q by means of the wire 5 with a battery.

In order to make their form and operation clear, the plate I, in figs. 28 to 31, has been shaded with vertical lines, and j' has been similarly shaded with horizontal lines. The plate I is provided with an oblong opening p''', sufficiently large to give the plunger some clearance therein, but the opening is not elongated sufficiently to permit the plate I, when the plunger is inserted through it, to fall far enough so as to bring the indicator B' into a position in which the word TRAIN ON, inscribed on the indicator, can be seen through the opening O', figs. 20, 21, and 25, in the indicator face. The movable section j' has an opening p'''', see figs. 28 and 29, through it, which comes opposite or over the opening p''' in the plate I, but which is sufficiently elongated to allow the plate j' to fall when the plunger is inserted, as shown in figs. 27 and 30, a distance sufficient to allow the nose p'', fig. 27, to move downwardly past the nose l'' on the arm E. When the section j' has reached this position, the withdrawal of the plunger, as shown in fig. 24, will permit the arm E to swing toward the front of the indicator case, and, as shown in fig. 24, will carry its nose l'' above the nose p'' on the section j', and thereby permit the drop-plate I and its movable section j' to fall the whole limit of their downward movement, as shown in figs. 24 and 31, and thus bring the indicator B' into a position behind the opening O' to show the words "TRAIN ON," which are inscribed on it. If the plunger be only partially withdrawn so that it still remains within the opening p''', fig. 27, in the plate I, then the section j' will fall far enough past the opening p''' so as to prevent the plunger from being again pushed into contact with the arm E until the plate j' has again been raised to its normal position. The plate j', fig. 20, is held up in its upper position by the engagement of the nose l'', on the arm E, under the nose p'' on the plate j'. As shown in figs. 24 and 27, the upper end t' of the plate j' engages with a projection u on plate I and thus holds it up. After the plate j' has once been lowered, it can only be raised by lowering the bar L, which is done by the outward movement of the knob H and bar $S\ S$. This brings the nose l'', on the arm E below the nose p'', see fig. 25, so that they can engage with each other. In order that the nose l'' may ride past the nose p'', and that the forward movement of the arm E will exert a downward pressure upon the movable section j', the upper side of the nose p'' and the lower side of l' are provided with beveled or inclined faces x and y', as shown clearly in fig. 24.

For the purpose of utilizing a single line-wire for connecting the instruments for moving the trains on both the incoming and outgoing tracks, a connecting strip, T, see figs. 20 and 25, is provided in permanent electric connection by a wire, 6, with the contact plate P'' of the companion instrument at any station, and normally connected with the line wire leading to the adjacent station by means of a connecting arm, q', carried by the depending strip T. When the strip N is swung inwardly, as shown in fig. 27, under the impulse of the plunger, the spring N will be disengaged from the arm q', and the circuit through the companion instrument will thus be broken while the circuit through the electro magnet at the next preceding station is closed.

The description of the operation of this instrument must be reserved until next month.

(TO BE CONTINUED.)

Electrically Welded Steel Barrels.—A large industry is being built up at Barrow, Eng., in the production of steel barrels for the conveyance of petroleum. The barrels are made in halves by means of compression in a mold, when hot. Afterward they are welded together by means of electricity. The barrels are intended for use by the large oil carrying companies engaged in the oil trade in the East, where the temperature has a great effect on wood casks, and results in so much leakage.

THE CYCLOGRAM OF PRESSURES IN STEAM-ENGINES.*

By F. Edwards.

In multi-cylinder engines it is desirable to know what is the fall of pressure between an exhausting cylinder and the cylinder receiving the exhaust. It is also desirable to get at a glance an idea of the course of the steam, the time it is waiting in the receiver, and whether the steam from the bottom goes to the upper side or to the under side of the next piston. Whether the object of this inquiry be the better understanding of the action of the steam, or the determination of the validity of diagrams received as a set, the requisite comparison of simultaneous pressures cannot be read directly from indicator diagrams. At the Board of Trade office I have been shown the cyclogram or clock-face diagram, a very simple and very effective way of exhibiting this information. Not having seen this before, I think it will probably be new to most of our members, and that it may have a place in our *Transactions*, I have had the cyclogram now exhibited constructed. In the cyclogram the simultaneous pressures in all the cylinders are represented on the same radial line, to the same scale, and the differences and the sequence of pressures are therefore directly readable. To make such a diagram correct, including the obliquity of the connecting-rods, seems at first sight to be a somewhat complicated and troublesome problem, but it is really extremely simple, and its construction occupies very little time. For example, let the engine be a triple with the cranks at 120°. Describe a circle, say 6 in. diameter, draw a vertical center line, and, starting from it, divide the circle into 18 equal parts by radial lines. Number these from the center line 0 to 18. The number of divisions must be an even number, and one of them must coincide with the position of each crank. With the proportionate length of connecting-rod set off the corresponding crosshead positions on the center line, and number these, down one side and up the other, 0 to 18. Draw a horizontal line through No. 4, and from a point in it draw straight lines to the other cross-head positions. Draw a few vertical lines across these at, say, half an inch apart. Take now the indicator diagrams, which ought to be without ordinates, and mark the extreme lengths on the atmospheric lines. Fold each card along its atmospheric line with the diagram outward. Lay the folded high-pressure card parallel to the vertical lines, and with its ends on the extreme converging lines. The parallels are a guide to the eye in placing the card. Mark the divisions on the card with a fine pencil. Open the card and draw ordinates through these divisions and number them as on the center line. Do the same with the other cards, but observe to number the divisions on the intermediate from 6 and on the low from 12. Let the 6 in. circle denote the line of atmospheric pressure. Set off from this atmospheric circle on the radial lines the pressures found on the cards at the respective ordinates. The pressures are converted to the same scale by the usual method of inclined lines. Join the points thus obtained, and, where there is a change of curvature between two of the positions, be guided by the form of the card. Having ascertained the points at which the exhaust begins and ends, indicate, by short radial lines inward, the duration of exhaust, and by short radial lines outward the duration of steam admission into the succeeding cylinder. Shade the effective pressure areas. Show the compression area by dark shading. When a diagram has been obtained from the receiver, its ordinates must be numbered according to the crank whose motion actuated the indicator barrel when the diagram was taken. A little consideration will show that the crank must be placed on the diagram in the reverse order of the action of the steam. For example, this cyclogram is for the high leading, but the low crank is placed as if it were leading. This is, however, correct, and a little reflection will show you that it must be so, and any verbal explanations would only be likely to make this more difficult to grasp.

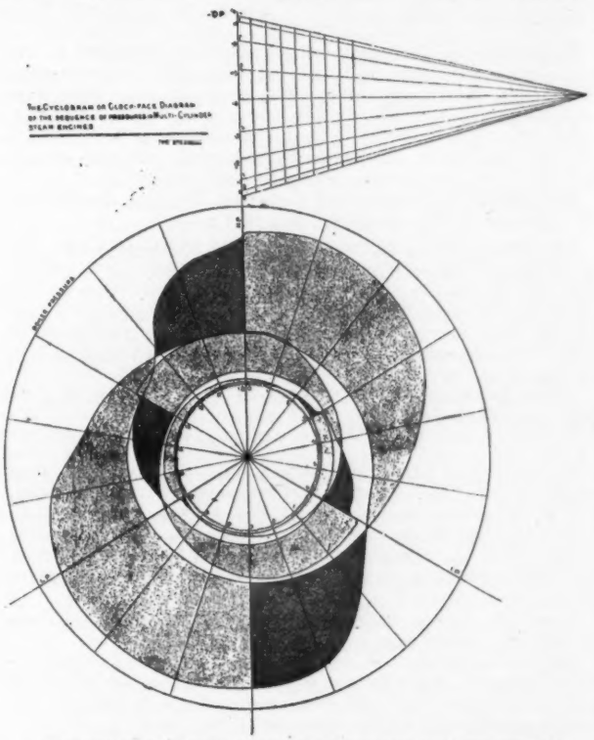


DIAGRAM ILLUSTRATING CYCLOGRAM OF PRESSURES.

* Paper read before the Institution of Naval Architects.

PROGRESS OF TRANSATLANTIC NAVIGATION.

The *Revue Scientifique* gives the following *résumé* of the progress in transatlantic navigation from 1816 to the present day. Regular transatlantic navigation, which was brought to life in this century, has made a steady advance, the principal stages of which are given by the following figures:

The first regular line, the Black Ball, was inaugurated between New York and Liverpool in 1816. At that time the outward trip to New York occupied 23 days, and the return trip 40.

In 1836 the Dramatic Line launched the ship *New York*, of 1,400 tons displacement, which was at that time the largest ship in the world. At this time the sailing vessels were undergoing a process of very rapid improvement, and 14 years later, or in 1850, the passage could be made in 15 days under favorable conditions.

Then steam navigation was established. The first attempt had been made in 1819 with the *Savannah*, which was practically a sailing vessel equipped with an auxiliary engine, and which occupied 25 days in making the passage between Savannah and Liverpool, and in consequence of this attempt the English declared, previously and afterward, that it would be impossible to make a passage of the Atlantic Ocean by the assistance of steam alone.

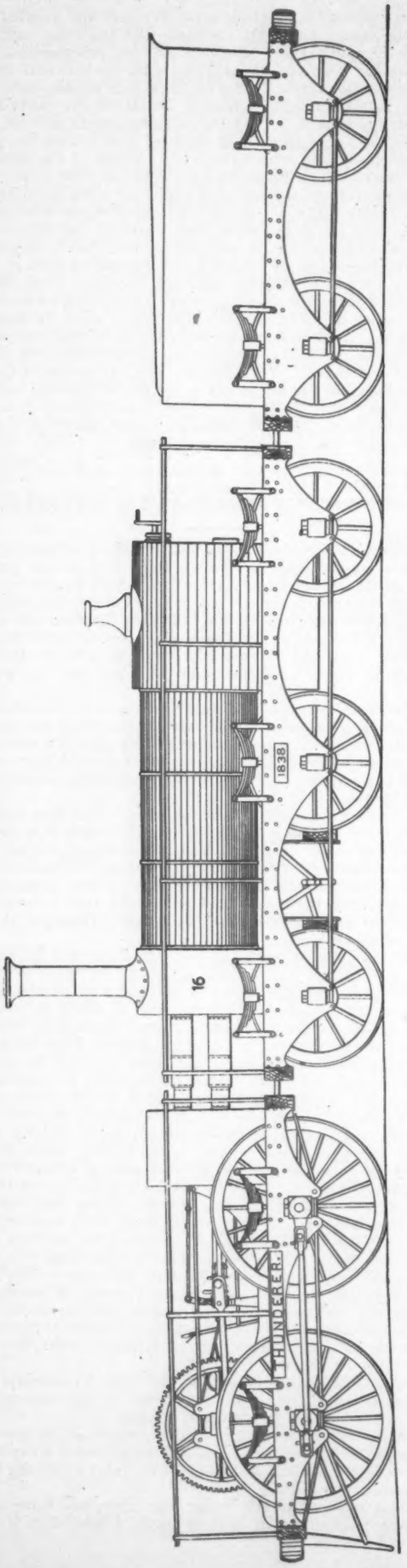
In 1838 the first steamer, the *Great Western*, was launched. She had a length of 213 ft. 3 in., a breadth of beam of 32 ft. 9.7 in., drew 16 ft. 4.8 in. of water and had a net displacement of 1,340 tons. She was equipped with a 440-H.P. engine. The first passage occupied 16 days, during which time from 27 to 32 tons of coal were burned every 24 hours. The return trip was accomplished in 14 days; and even in 1842 the record stood at 12 days, 7½ hours, which corresponds to a speed of about 8¼ miles per hour. A great step in advance was made when the *Great Britain* was built, with a length of 275 ft. 7.2 in., an iron hull, a screw propeller and an engine of 1,000 H.P.

As for the *Great Eastern*, that giant among ships, which measured 690 ft. in length, having a breadth of beam of 82 ft. and a depth of hold of 55 ft. 9 in., with a net tonnage of 18,915 and engines of 2,600 H.P., it was very evident that she had come before her time. She was furnished with accommodations for 4,000 passengers, without counting the 400 men constituting the crew. The steamer was, nevertheless, very well built, and obtained a speed of 14 miles per hour on her trial trip. But at that time there was no such throng of passengers traversing the Atlantic as there is to-day, and the traffic was insufficient to make her voyages paying investments; so that, after having been used for laying transatlantic cables, she was finally broken up in 1891.

In 1862 the French Compagnie Générale Transatlantique was organized, and from that time on the rivalry between the great lines has been on the constant increase.

In 1866 the *Pereire* was built, which crossed at the speed of 13¼ miles per hour, and was really a magnificent steamer of 6,000 tons burden. She was 374 ft. long, and equipped with an engine of 3,000 H.P.

In 1875 a new-comer, the White Star Line, had some ships 465 ft. long, with a beam of 46 ft., a depth of hold of 32 ft., and a speed of 14 knots.



LOCOMOTIVE "THUNDERER," WITH 6-FOOT DRIVING-WHEELS, BUILT IN 1838.

Since 1880 there has been a greater struggle than ever among the transatlantic lines to produce the largest and fastest steamer. In 1881 the Inman Line launched the *City of Rome*, which has a length of 544 ft., a beam of 55 ft., a depth of hold of 39 ft., a displacement of 8,400 tons, and a speed of 18 knots, which was made with an engine of 11,900 H.P.

In 1891 the Compagnie Transatlantique built the *Touraine* with a length of 515 ft., a beam of 55 ft., and an engine of 12,000 H.P., which gave them an average speed of 19 knots.

Finally, the latest comers are those of the Cunard Line, which has just launched two immense liners, the *Campania* and the *Lucania*, with a length of 597 ft., a beam of 65 ft., a depth of hold of 42 ft., a total tonnage of 12,500 and engines of from 14,000 H.P. to 15,000 H.P.

Regarded from the standpoint of the length of passage, the *City of Paris* at present holds the record, having made the trip from Queenstown to Sandy Hook in 5 days, 14 hours, and 24 minutes, which gives an average speed of 20.7 knots—a speed which has even reached that of 21.4 knots for a single day, or practically about 24.855 miles per hour.

LOCOMOTIVES "HURRICANE" AND "THUNDERER."

In our issue of February last we gave an engraving of the locomotive *Hurricane*, with driving-wheels 10 ft. in diameter, the largest which have ever been used. In the description which was given of this engine it was stated that, "as originally built, it had drivers 5 ft. in diameter, and the cylinders were coupled to an independent crank-shaft carrying a large pinion which geared into another on the driving-axle."

Mr. Clement E. Stretton, of Leicester, England, has written to us to correct this statement, and says:

"With regard to the *Hurricane*, the illustration on your p. 80 shows that engine as it was when built. *It was never altered;* but proving a failure was broken up. The engine illustrated in Wood's book of 1838, having four coupled wheels of 6 ft. diameter, is not the *Hurricane*, but the *Thunderer* of 1838. The *Thunderer* had 6 ft. wheels geared up three to one, so as to equal 18 ft.

"To make this quite clear to your readers, I beg to send by this post a blue print of the *Thunderer*.

"CLEMENT E. STRETTON."

The engraving herewith has been made from the blue print received from Mr. Stretton. His statements are confirmed, too, on a further examination of Wood's book. In his sixth chapter, p. 352, he says that "the Messrs. Hawthorn are now constructing an engine for that railroad (the Great Western), with driving-wheels 10 ft. in diameter, calculated for a speed of 40 miles an hour."

In a later chapter, which was evidently written after Chapter VI., Mr. Wood says:

"With wheels of 10 ft. in diameter, the velocity of the piston is reduced nearly to the proper standard; but wheels of so large a diameter are very cumbrous and heavy, and produce a very considerable strain upon the axles.

"Mr. T. E. Harrison, Engineer to the Stanhope & Tyne Railway, has obtained a patent for an engine to obviate these inconveniences and objections, the driving-wheels of which make three revolutions for one entire stroke of the piston; and these wheels being 5 ft. in diameter, they are equivalent in speed to one wheel 15 ft. in diameter."

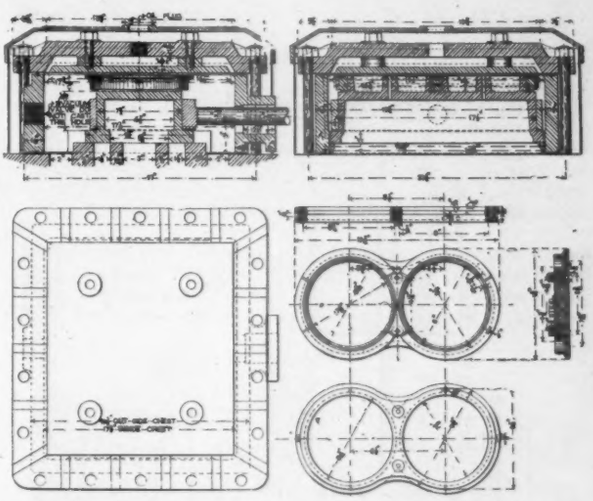
Quite an elaborate engraving is given of the engine showing a longitudinal section of the front or driving part of the machine, and its connections with the vehicle which carries the boiler. Measured on the scale given with the drawing, the driving-wheels measure 6 ft. 2 in. in diameter. Quite a full description, apparently taken from Harrison's patent, is given of the construction of this machine. At the end of the description Wood says: "One of these engines, constructed as shown in the drawing, and another without cog-wheels, and with the driving-wheel, *W*, 10 ft. in diameter, have been furnished by Messrs. R. & W. Hawthorn, of Newcastle, for the Great Western Railway."

THE LUBRICATION OF MARINE ENGINES.

At a recent meeting of the Institute of Marine Engineers, Mr. W. M. Ross presented a paper on the Lubrication of Marine Engines, of which we present a brief abstract:

The references in this paper were solely to vertical marine engines. No doubt they could be applied to other machinery as well, but the greatest number of marine engines of the pres-

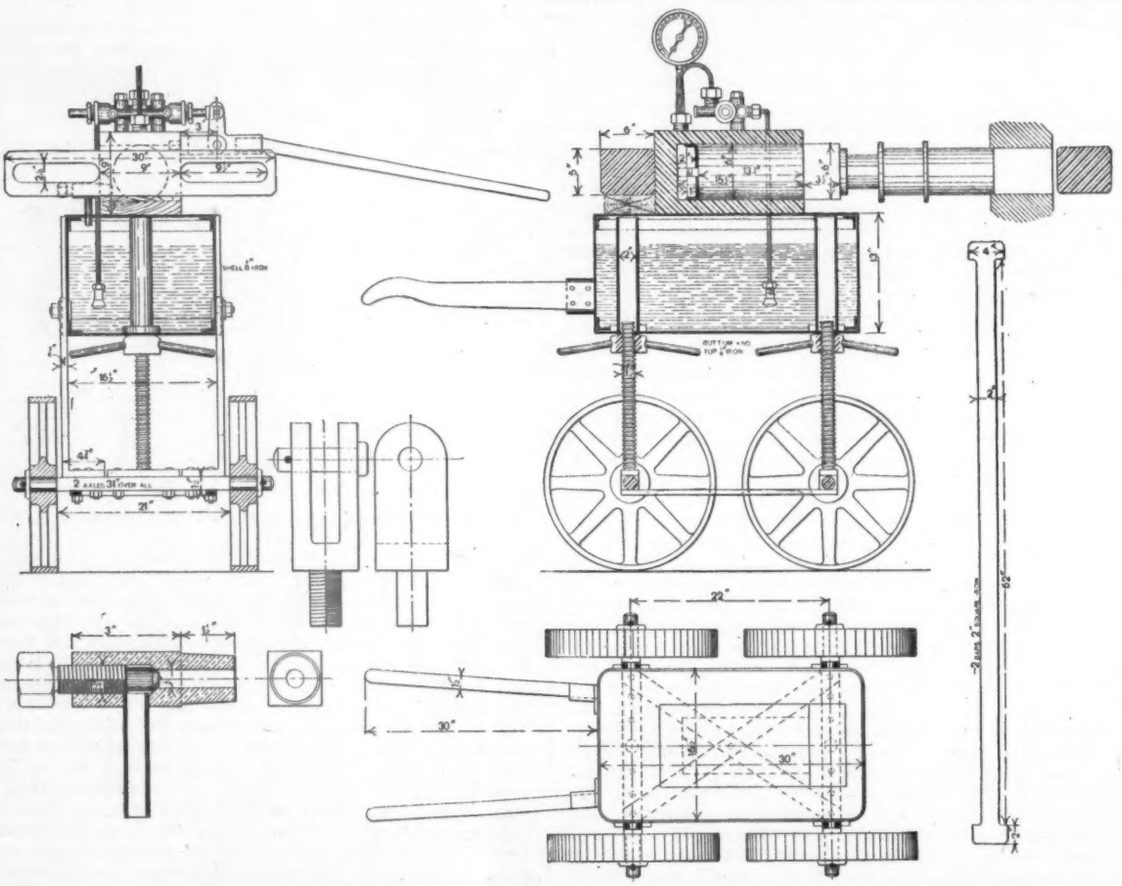
ent day are of the vertical type. Lubrication might be divided into two classes—external and internal. Let them first consider the external. One of the principal parts of a marine engine was the crank-shaft and its various bearings, to which too much attention could never be given. In boring out bearings for a crank-shaft the general rule was to give a greater diameter than the shaft which had to revolve in them, a difference which might vary with the engineers, but in all cases the hardest points to come into action were the top and bottom centers and a gradual enlargement toward the sides. In the present method of supplying lubrication to these bearings, all oil holes were bored through the top center, and to enable the bearing to receive sufficient oil to overcome friction the outlets had to be greatly enlarged, and oil channels cut all over the bearing surface. This he considered wrong, and one of the greatest defects in anti-friction that could occur in any bearing in which the shaft had a revolving motion, as the sides of the bearings (and by that he meant any part away from the top and bottom centers) must have the greatest division of the two metals—in other words, less friction. Therefore the outlets should be distributed into that space, so that the shaft in revolving would carry its lubrication with it, drawing its supply as from a reservoir—inducing a better flow down the oil pipe instead of retarding it, as must take place when the pipes led directly to the top center of the bearings. Were it not for the enlargement of the oil tubes and the channels cut over the surface, no lubrication would take place in these bearings at all. Nearly all main bearings were now fitted with white metal, or some other less tenacious metal than the brass itself, and were generally fitted in the outer brass or cast iron, as the case might be, in strips of about 4 in. in width, having one division on the top center into which the oil holes were led. This method had its advantages, but he thought that if this white metal were to be divided into three surfaces—that is, with two intermediate divisions only—they would give the bearings a better opportunity to distribute its work through all the component parts. They required only a bearing surface equal to the diameter of the shaft to insure a correct bearing, and, instead of the arrangements of the present day, they would get the oil supplied into the space on either side, and the whole metal be left as bearing surface on the bottom and top centers, the principal points of these bearings. He considered that all bearings in which the working part had a revolving motion should be supplied with lubrication not on the top center, but at some point away from that center. Then each side of the bearing would always have a better supply, and as a result they would have less friction, and consequently greater power. With regard to the lubrication of the crank-pin, the same defect was here seen as in the main bearings, and if it was wrong in one case, here it must show with greater force. The principal defect in crank-pin lubrication was, he thought, in the method of supply from the boxes, as at present fixed in most marine engines. The method of to-day, although without a doubt a great improvement upon the old style, fell, he thought, far short of perfection. Let them trace the connections. Generally they had a box fixed high up on the cylinder lagging, with pipes leading to another cup fixed on each side of the connecting-rod jaw; from these cups led other pipes (usually one from each) to another cup, fastened to the center of the connecting-rod, or at such a distance as to give clearance from the bottom corner of the guide, and to be handy for any oil to be given as the rod is working. From this cup ran three pipes, one to each side and one to the center. Now, from this last cup ran three outlet pipes, but it had only two supplies, and these two, in five sets of engines out of six, led directly over the side outlets; the center pipe got its supply only by chance. He considered that every outlet should have its own special supply. From the first box there should be sufficient oil supplied to guarantee each of the pipes leading into the brass getting its own proper amount regularly, and on no account should this most important bearing be left to chance lubrication, as in some cases at present. With engines running at the high speed of to-day, and with the long connecting-rods now in use, it was impossible for this pin to be oiled except automatically, let the greaser be ever so good; still there must be a great percentage lost when oil had to be supplied in this offhand manner. How many crank-pin bearings to day could be run without using the water service, which, although at times a blessing, when considered relatively to the life of the shaft and bearings was far otherwise. Many an anxious watch was passed and many a gallon of oil was wasted through this defective supply to a bearing. He hoped he had sufficiently shown the defect to justify a remedy as follows: Place the outlet holes not on the top center, but somewhere on the sides; give each hole an independent supply pipe, and, if the engine is properly balanced, there will be a much better working pin, and with better working we have less friction, and consequently longer life to both pin and bearings. After referring to tunnel-shaft bearings, and especially to what he considered the great room for improvement in the lubrication of the thrust block bearing, Mr. Ross said that the defects he had pointed out were common; and in the marine engine of to-day, brought up as it was to great perfection in design, lubrication should not be looked over or slighted. Regularity was one of its chief features; and let the "greaser" be ever so careful and competent, there must at times be periods in his watch, either through rough weather or extra attention required at some particular part, when this regularity could not be carried out; consequently bad lubrication took place. Every bearing throughout the engine should be supplied automatically and regularly, and if it could be carried out in small engines (as was now being greatly done), how much easier could it be arranged with the large machines of to-day. Perhaps at this point a few words might not be out of place in regard to the rule in a good many steamers (not liners, but in what were called outsiders or tramps) of the engineers having to oil the machinery unaided. In these times, when they were trying to elevate themselves and those who were to follow them, and to bring a more scientific training into every-day use, it seemed very wrong that trained engineers should be turned into oil feeders. No engineer in charge of a watch could properly devote his attention to all in his charge, be it ever so small, if his time had to be given up to oiling; something must be neglected. Without doubt there had been a great improvement in recent years in internal lubrication. The old pot impermeator had been entirely superseded by the automatic sight-feed—an arrangement in all its workings simple and effective. With the old style, oil was



BALANCED SLIDE-VALVE, DELAWARE & HUDSON CANAL CO.

generally put in twice a day; if it worked, well and good; but generally it did not. Now, every drop told a tale, and gave the satisfaction with the knowledge that all was going well. In the present day, with steam of very high temperature, little or perhaps no internal lubrication was necessary. Many engineers had entirely discarded the supply through the impermeator. But with this he did not agree. Granted that the high-pressure steam required no oil, when this steam reached the low-pressure engine the temperature had decreased greatly, and here it was where he always found the most mischief took place. With the large working area of the low-pressure piston, some lubrication, he considered, was necessary; very little sufficed, but still some was required. If the impermeator, instead of supplying the oil to the steam at its first initial pressure, were so placed that the supply could be given at the time the steam entered the low-pressure valve chest, he really thought more good would be done, as the lubricating properties of the oil would not be destroyed through coming in contact with steam of high temperature, but would pass at once into the parts requiring it most. With internal lubrication, they must not overlook that taken in with the piston-rods, an amount, he was afraid, greatly overlooked by most engineers in their calculations. Although oil given to these rods could not be absorbed by the steam, still he considered at least 20 per cent. was used for that purpose; and on no consideration should any but mineral oils be used. With engines having top end rods automatic supply was very easy, and the bottom rods could be as easily supplied as the top, and from his own personal experience good results had been obtained, not only in the life of the packing, but in the wear of the rods

themselves. With a pair of engines of 2,500 H.P., he found that the piston-rods (with top ends oiled automatically), and three valve spindles, required one pint per watch of four hours' duration—*i.e.*, six pints in 24 hours. Now, if, as he maintained, a fair percentage was absorbed by the steam while the rods were internally working, they had one to two pints used from this source alone for internal lubrication, and the impermeator, being fixed to the low-pressure valve chest, would use .8 pint. They had, therefore, used two pints in the 24 hours. Not a very large amount, and he did not think it could be very much reduced. In closing, Mr. Ross said he would call friction the strongest enemy in a marine engine, and if lubrication was the best way to overcome it, the most perfect method should be adopted. The following points had been present to his mind while writing: 1. All revolving shafts should be supplied with lubrication, not through the vertical center, but somewhere at the sides. 2. Every supply outlet to the crank-pin should have its own separate supply inlet from the commencement to the finish. 3. Each and every bearing, whether small or great, should be supplied automatically; there should be no chance lubrication in connection with a marine engine of to-day. 4. No internal lubrication should be used, excepting through the impermeator affixed to low-pressure engine, and lubricating or swabbing piston-rods and valve-rods, with mineral oils alone. 5. Greater thought and more care should be given by designers and builders to the lubricating arrangements, and less to the superfluous water service, as at present. 6. No marine engineer of modern training should be asked to act as the oil feeder of the watch; he has more important duties to attend to.



CRANK-PIN PRESS, DELAWARE & HUDSON CANAL COMPANY.

SPECIAL TOOLS OF THE DELAWARE & HUDSON CANAL COMPANY'S RAILROAD.

BALANCED SLIDE VALVE.

THE balanced slide valve of which we give a full detailed illustration is in general use upon the locomotives of the road, and is being applied to all engines as they come into the shop for repairs if they have not been equipped with it before. The principal feature wherein this balanced valve differs from those in ordinary use is that the balancing backing at the top is round instead of square, which makes it far cheaper to manufacture and to maintain. Of course they do not obtain the same area of balanced portion of the valve that is obtained when the packing comes out square and full with the whole upper surface, but sufficient balancing is obtained so that the valve runs very easily and the saving in the manufacture is considered to more than compensate for the extra loss of power required in driving the valve.

The steam-chest is of the same shape as that ordinarily used, and the cover has the balance plate cast separate from it and is held to it by bolts as shown in the top of the engraving. The plan shows the method of making the packing rings, which consist of two circles brought as near together as possible with the ordinary form of packing rings slipping down over a circular section and provided with the spiral springs for holding them down in position as is shown.

CRANK-PIN PRESS.

This press is a very convenient portable machine, which is used about the shops for removing and putting in crank-pins while the drivers are still under the engine.

Its construction and general dimensions are very clearly shown by the engravings. It will be seen from an examination that the press is mounted on a four-wheeled truck, and that the tank and body of the press itself are carried on screws by which it can be elevated or depressed so that the center line of the ram will come in line with the center of the crank-pin when the press is to be used.

The bars shown at the right of the engraving are used to lock into the spokes of the driving-wheel, and also into the tail-bar back of the press. The pressure can then be applied and the pin forced in as shown in the side elevation and section of the press. The ram is 6 in. in diameter, and the cylinder will sustain a pressure sufficient to put in any pin that may be desired.

The pumping arrangement is very simple, and is located on top of the ram with a bell crank attachment for operating the plunger and for connecting a lever which is 36 in. long and made by $1\frac{1}{2} \times \frac{1}{4}$ in. iron. When the press is in use, although it is carried on top of the tank, no strain is put upon the latter except merely that of carrying the dead weight of the ram.

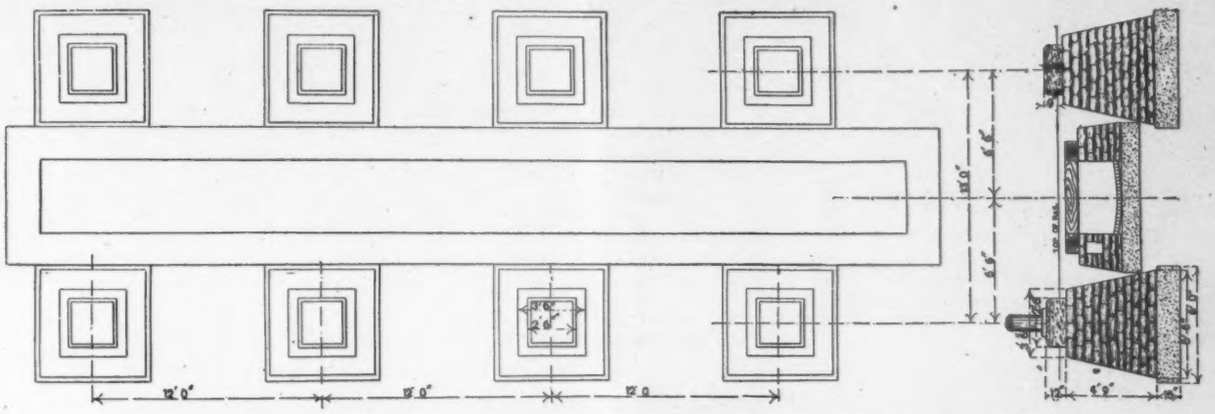
The wheels are of cast iron and run loose on the wrought-iron axles. The screws which are used for elevating and de-

pressing the plunger run in the sleeves in the interior of the tank, so that they are out of the way, and there is no necessity for any other provision being made for them. The general construction and operation of the press will be very readily understood from an examination of the engravings.

HYDRAULIC LOCOMOTIVE LIFT.

Probably two of the most valuable and useful special tools that are in use upon this road are the hydraulic locomotive lifts in the Green Island and Whitehall shops. As that used in the Green Island shops was the first one constructed, and as several improvements have been made in the one built later for the Whitehall shops, we limit our description and illustrations to the latter.

The general plan of the lift is that it consists of four inverted hydraulic cylinders so arranged that they can be shifted and brought into such a position that any locomotive on the road can be very readily and rapidly lifted from its wheels. The foundation plan shows that there is a pit with stone side walls beneath the track, and that on either side there are four columns of cast iron resting upon stone foundations located 12 ft. apart from center to center, with a central distance across the track of 13 ft. These columns rise to a height of 17 ft. 9½ in. and carry on their upper extremities two 15-in. I-beams, weighing 150 lbs. to the yard, and 38 ft. long. It is estimated that the safe load for these beams on the 12-ft. span between the columns is 11 tons.



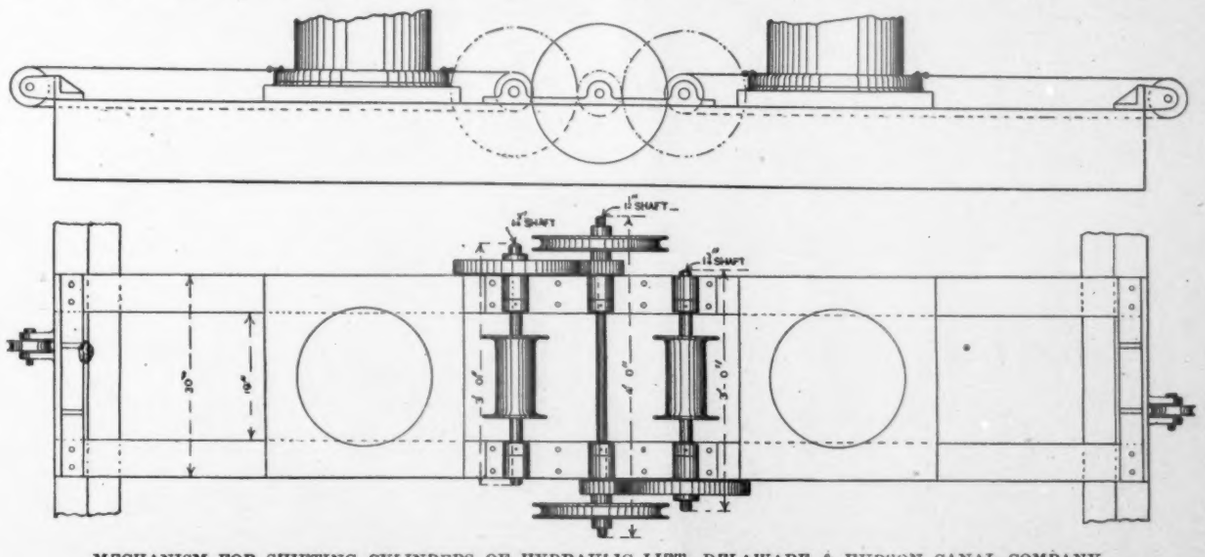
FOUNDATION FOR HYDRAULIC LOCOMOTIVE LIFT, DELAWARE & HUDSON CANAL COMPANY.

Near one end, which is used for the back end of the locomotive, there are two 12-in cross I-beams, weighing 170 lbs. to the yard. These are riveted fast in position and carry two hydraulic cylinders 18 in. in diameter and 6 ft. long on the inside.

The general construction of the piston which is used is clearly shown by the detail engravings. It consists of a spider against which an ordinary leather packing with a spider back of it is placed; then against this second spider there is a second leather backing, the whole being drawn up into position by a follower plate 1 in. thick. As these cylinders are only called upon to operate in one direction, the packing is turned downward so that the second one tends to supplement the first and catch any leakage which may pass through it. These two back cylinders are spaced 10 ft. from center to center, which is far enough apart to have their piston-rods clear the extreme outer ends of the bumpers or tail bars of any locomotive on the road.

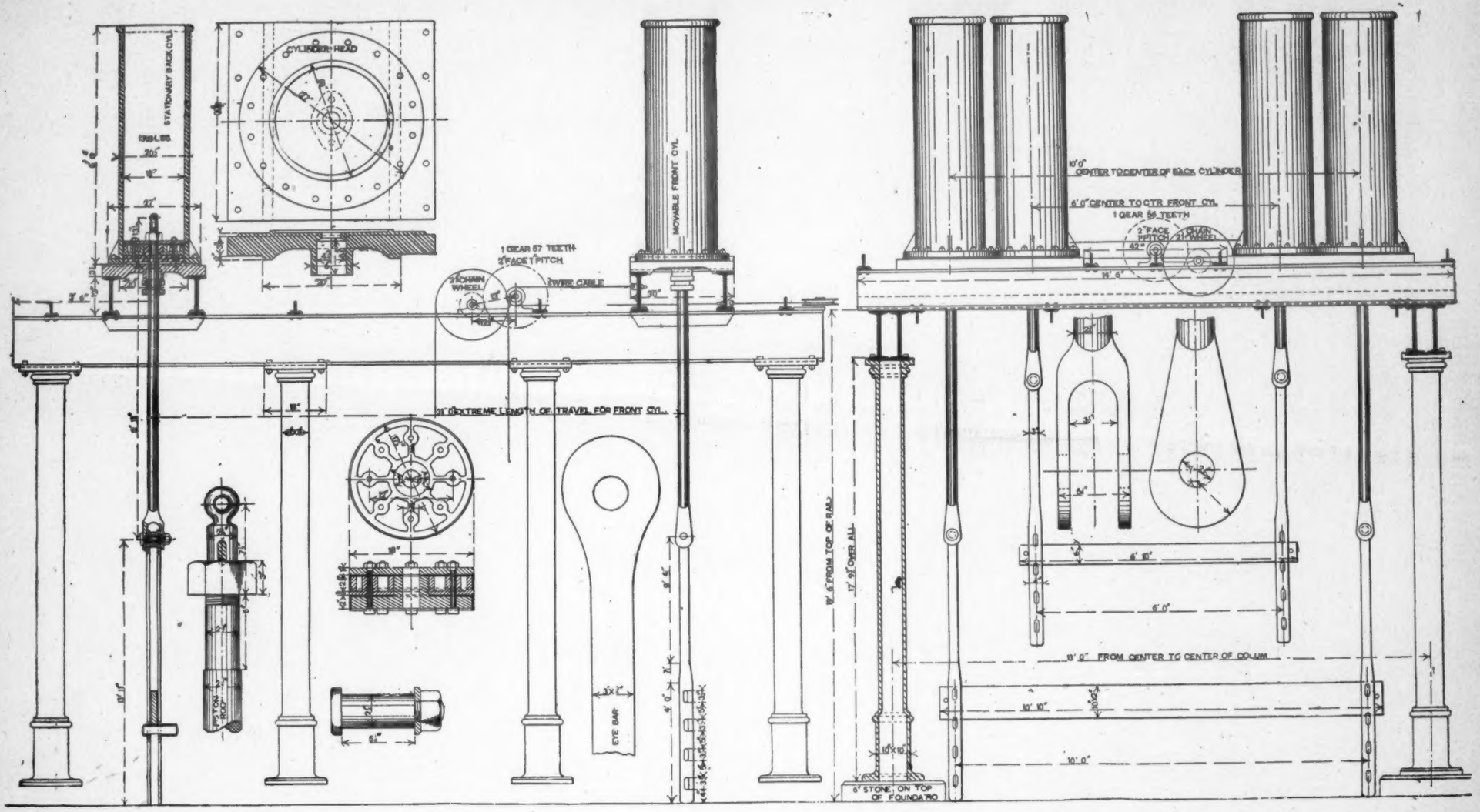
The piston-rods are held in the pistons by means of a nut over which a key is driven in order to prevent it from backing off. The thread where the nut screws on is 2¼ in. in diameter, while the piston-rod is 2¾ in. This rod is 6 ft. 11 in. long from the shoulder at the bottom of the piston to the center of the pin of the hangers. Two bars of 3 in. × ¾ in. iron are suspended from the piston-rod, and they in turn are fitted at the lower extremities, as shown by the engraving, with keyholes upon which a cross bar of 10 in. × 2 in. iron is laid, which acts as a direct lifting bar on which the locomotive to be raised rests.

At the front end there are two cylinders of the same size as those at the back, but they are movable both across the frame and lengthwise with it. This is in order to enable the workmen to adjust the suspension rods so that they will clear any projecting part of the engine and come to the exact point at which it is most convenient to apply the lifting strain. On ordinary locomotives they must be adjusted so as to come just ahead of the cylinder and back of the front buffer beam. The piston-rods are of the same size as those at the back and the suspension rods the same; the principal difference between them being that the cross bar which goes beneath the engine is of 6 in. × 1¼ in. iron instead of 10 in. × 2 in.



MECHANISM FOR SHIFTING CYLINDERS OF HYDRAULIC LIFT, DELAWARE & HUDSON CANAL COMPANY.

These movable cylinders rest on cast-iron bed pieces which are arranged so as to slide back and forth on the cross channel beams supporting them, and these channel beams are themselves made so that they slide longitudinally on the 15-in.



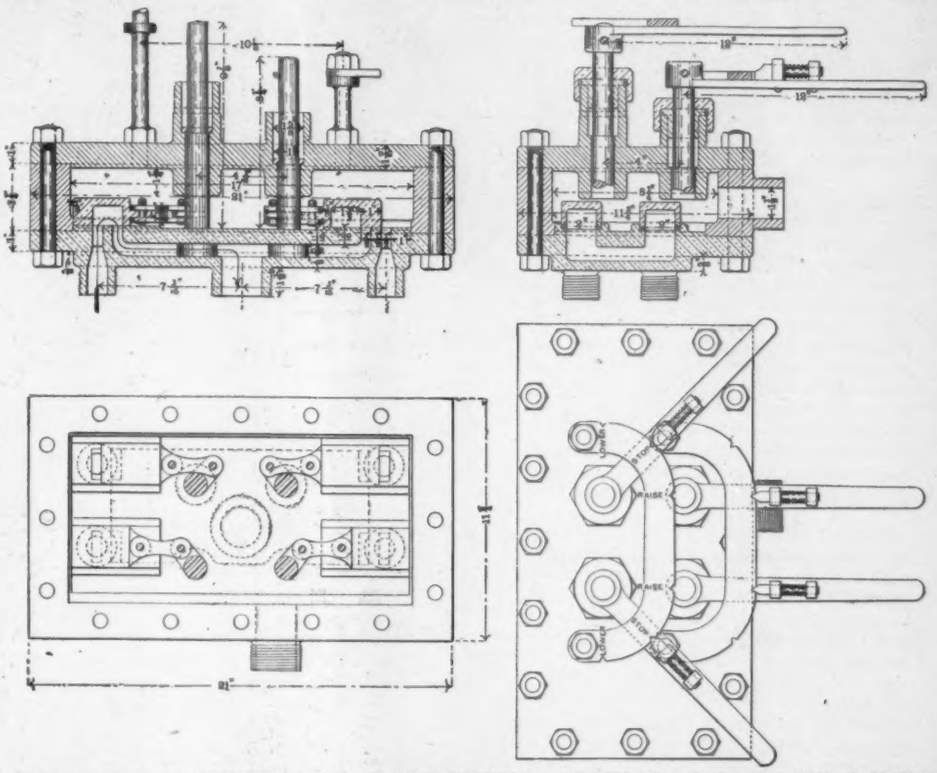
HYDRAULIC LOCOMOTIVE LIFT, WHITEHALL SHOPS, DELAWARE & HUDSON CANAL COMPANY.

beams that rest on top of the columns, the latter being planed off so that there is a smooth bearing surface for the cross-beams. The mechanism which is used for shifting both the cylinders and the I-beams is a very simple construction. It consists merely of a couple of spools with geared shaft so arranged as to wind up on one and slacken off on the other, with a wire rope running around an idle sheave at the extreme front end of the lift. The arrangement used for moving the cylinders is shown by the detailed drawing. Here the two spools are in line with one another, each one operating a cylinder.

It will be seen that the rope starts from one cylinder, passes over the drum and beneath the cylinder over the idler below, and takes hold of the base of the cylinder on the opposite side from that on which it starts, so that by reversing the motion of the drum the cylinders are drawn toward the center or outside of the frames by exactly the same amount, thus maintaining them at equal distances at either side of the center line. The rapidity with which locomotives can be raised and the driving-wheels removed with this apparatus is very great. On one occasion in the Green Island shops, where the lift is not considered to be rapid in its motion, or as effective as that illustrated, a locomotive was lifted from the driving-wheels, the wheels rolled out, and the engine put back on its blocking in 2¼ minutes.

The capacity of each cylinder with a 5-ft. stroke is 65.34 galls. Working under 95 lbs. natural pressure and a ½-in. nozzle, it requires 6 minutes to fill the four cylinders. By using a double 3 in. × 6 in. force pump the four cylinders can be filled in 9 minutes, or 120 revolutions.

The total weight of the cast iron used in the machine is 17,912 lbs., and wrought iron 14,709 lbs. The valve arrangement for manipulating the hoist is a very simple construction, and is shown by a special engraving. Water is taken under pressure of about 80 lbs. and admitted to a box with a cover $1\frac{9}{16}$ in. thick. From the bottom of this box there are five pipes, four of which lead, one to the bottom of each of the four cylinders respectively, entering beneath the lowest position of the piston. The fifth is an exhaust and leads to a sewer or other discharge.



OPERATING VALVE FOR HYDRAULIC LOCOMOTIVE LIFT. DELAWARE & HUDSON CANAL COMPANY.

There are four handles, as shown by the plan view, and the whole is placed in a pit just back of the pit beneath the lift. Each one of these handles controls a slide valve which covers the opening into the pipes leading to the cylinders. When it is desired to raise, the handle is simply pushed so that the catch drops into the notch marked "Raise;" water under pressure is then admitted from the main into the bottom of the cylinder corresponding to the handle manipulated. When a sufficient height has been reached, the handle is moved to the "Stop" position at which the slide valve covers the opening and holds the water in the pipe and cylinder, thus preventing the piston from descending. When moved further to the "Lower" position, the water flows back through the same pipe and out of the *D* of the valve into the exhaust. The amount can be regulated so that the engine can be lowered with any speed desired.

It is well known as one of the difficulties where engines are hoisted by jacks or other rigid means, that when it is desired to replace the wheels, generally the engine is a little out of the center line of the track, and that almost invariably the wheels will be crowding one rail or the other, so that it requires a deal of pinching and crowding in order to move the engine until it stands central with the wheels upon which it is to be placed. With this lift, however, the engine can be swung like a child in an ordinary swing, and one man can very readily adjust it so that the pedestals will drop down over the driving-boxes at once and without any undue exertion.

GERMAN CORRIDOR TRAINS.

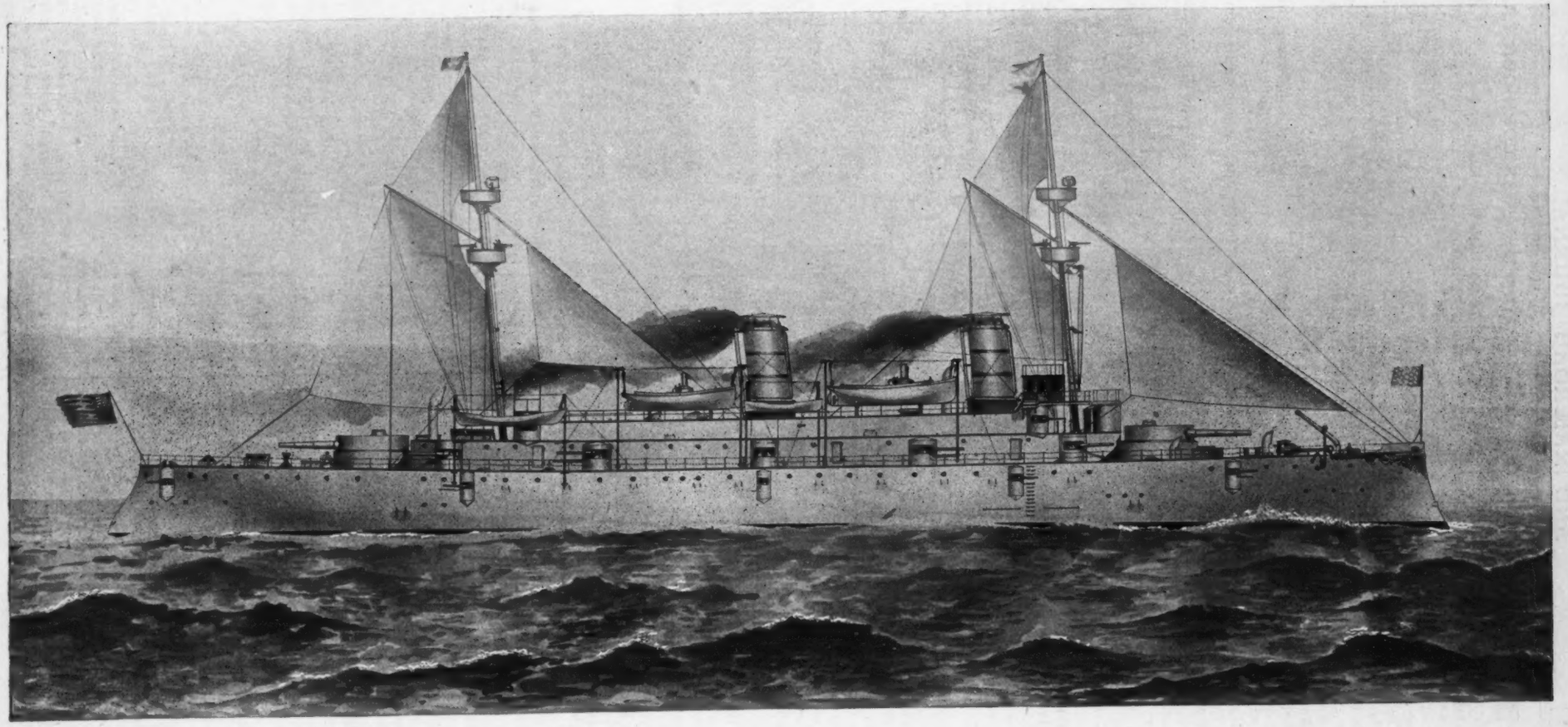
THE success which has attended the introduction of corridor trains on various European railways has induced the administration of Prussian railways to order a number of them for their express traffic. Since May 1st, twenty-four such trains have been running on the lines worked by the Prussian State, more especially between Berlin and Cologne, and Berlin and Frankfort-on-the-Main. It may be remarked that corridor carriages are of German origin, having been first designed by the late Hensinger von Waldegg; the principle was applied, however, only to four and six-wheel carriages, which were provided with lavatories at one or both ends. Since 1875 this design has received numerous applications, and new stock for foreign railways is built according to it, in preference to the older system with central passage.

The twenty-four trains of which we are going to give a description embody all the features of the modern American rolling stock. Each train consists of five bogie carriages, which have the same external appearance as those owned by the International Sleeping Car Company; the bogies are four-wheeled and of the usual pattern. Thorough communication from one end of the train to the other is established by means of small bridges uniting the end platforms of the cars, and in order to afford better protection against accidents to passengers going from one car to another, each bridge is completely covered by a leather awning, as is done in England to connect mail vans. These cars are 52 ft. 11 in. long, and each one of them is provided with two lavatories.

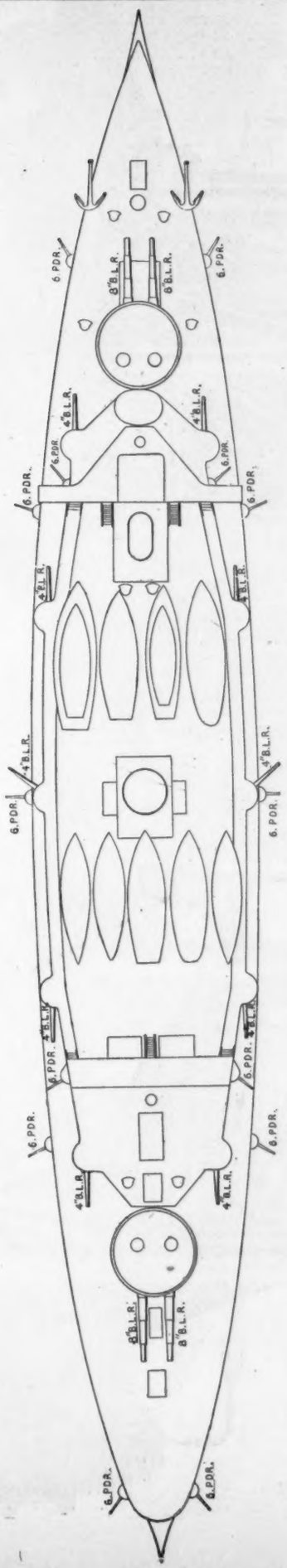
The Westinghouse brake has been fitted on all these trains. The lighting is effected by means of regenerative gas lamps. The last car but one contains a restaurant and kitchen, where cooking is done by gas. The catering of these dining cars will be leased to private refreshment contractors. Communication between this car and the others is effected by electric bells. One guard and train conductor will be the only railway servants attached to the train; the first will travel in the luggage van and the second in the anteroom of the last car.

The trains contain 126 seats each; 24 to 30 are first and the remainder all second-class. Each car contains seats so constructed that when not occupied they stand vertically, and are kept automatically against the sides of the car. This arrangement is generally met with in all German corridor carriages of more or less recent construction. As usual, special compartments are set apart for non-smokers and ladies traveling alone.

All places are numbered, and particular seats can be secured in advance on payment of an extra charge of one mark; but these must be applied for at the booking office at least half an



UNITED STATES PROTECTED CRUISER "OLYMPIA," BUILT BY THE UNION IRON WORKS, SAN FRANCISCO, CAL.



UNITED STATES PROTECTED CRUISER "OLYMPIA." DECK PLAN.

hour before the departure of the train. When a seat has thus been engaged a special notice is attached to it showing that it is reserved.

Some of the ordinary express trains, with the usual first and second-class, will continue to run as in the past; but if we understand it right, on some lines passengers wishing to travel by these new *trains de luxe* will be charged a supplemental fare of two shillings. This extra fare may be paid at the booking office or to the train conductor.

The maximum dimensions adopted by the Union of German Railway Administrations for the construction of cars being of a more liberal nature than those which obtain in England, German engineers will have no difficulty in providing comfortable and roomy corridor cars in which the proportion of paying to dead load will be no greater, if not actually less, than it is in the four or six-wheel stock of the antiquated English pattern with rigid wheel bases.—*The Railway Herald.*

U. S. PROTECTED CRUISER "OLYMPIA."

THIS man-of-war represents the first high-speed vessel of the protected cruiser type designed for the new Navy of the United States to meet the conditions imposed by the rapid development of quick-firing guns and shell filled with high explosives.

Features hitherto unattained in this type have been introduced in the protection given to the battery and stability of the vessel. Experiment has established the fact that shells of small size filled with melanite, cordite, or like substances, when exploded near the side of the vessel in the vicinity of the load-line, have the effect of tearing away large portions of the thin plating which forms the sides of all unarmored cruisers, thus leaving the portions of the vessel above the protective deck open to the water, the protective deck itself being of sufficient thickness to preclude any possibility of damage to the vitals of the ship, which are placed beneath it, from the fragments of small shell; but with the admission of water to the portions above this deck the stability of the vessel is lost, therefore some means, where the use of armor plating is not admissible, must be adopted to keep out the water and thus maintain the stability.

To accomplish this the usual practice has been to divide the compartments above the protective deck into a large number of cells, making it necessary to fill a number of them before the seaworthiness of the ship is affected to a serious extent. In this vessel, however, the security resulting from cellular construction has been augmented by working an enclosed belt of water-excluding material 3 ft. wide and 8 ft. deep around the entire vessel, the weight of the material being about one-sixth of that of a corresponding bulk of water. This has the effect of providing a double hull in the vicinity of the water-line for the full length of the ship. Inside of this belt the cells in the wake of boilers and engines are filled with coal, thus reducing the possible admission of water to a minimum.

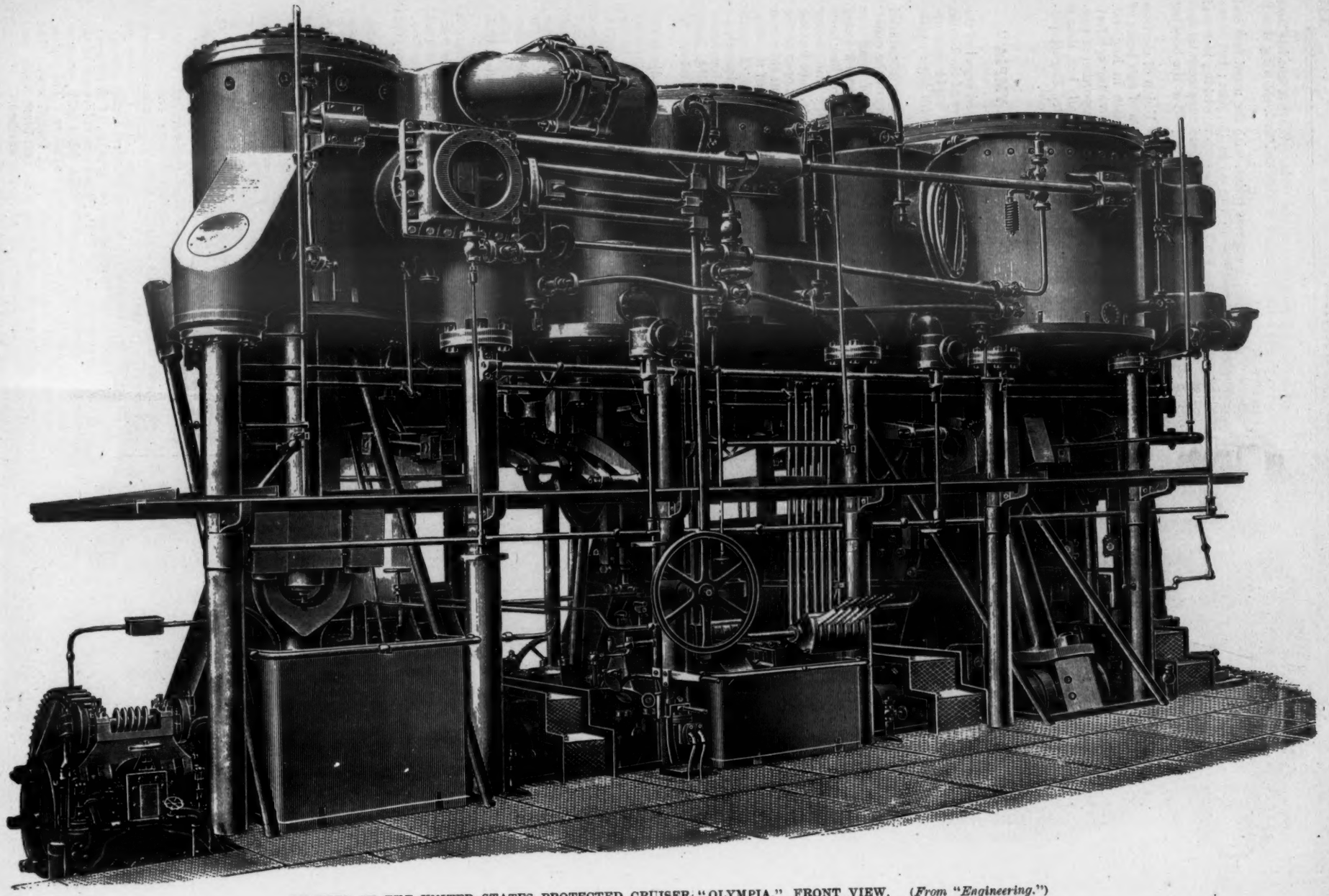
The protection given to the battery in unarmored cruisers is generally a light shield attached to the guns; but the 8-in. guns of the *Olympia* are mounted in barbette turrets protected by Harveyized armor plates 4 in. in thickness, while the 5-in. and other rapid firing guns are protected by armor varying from 4 to 2 in. in thickness.

The hull is constructed on the longitudinal system, with double bottom extending over the space occupied by the magazines, boilers, and engines, throughout which the frames are spaced 4 ft. apart, giving an area of bottom plating unsupported of some 25 sq ft. in each frame space. Mild steel is used throughout as the material of construction, with the stem, sternpost and shaft struts of cast steel.

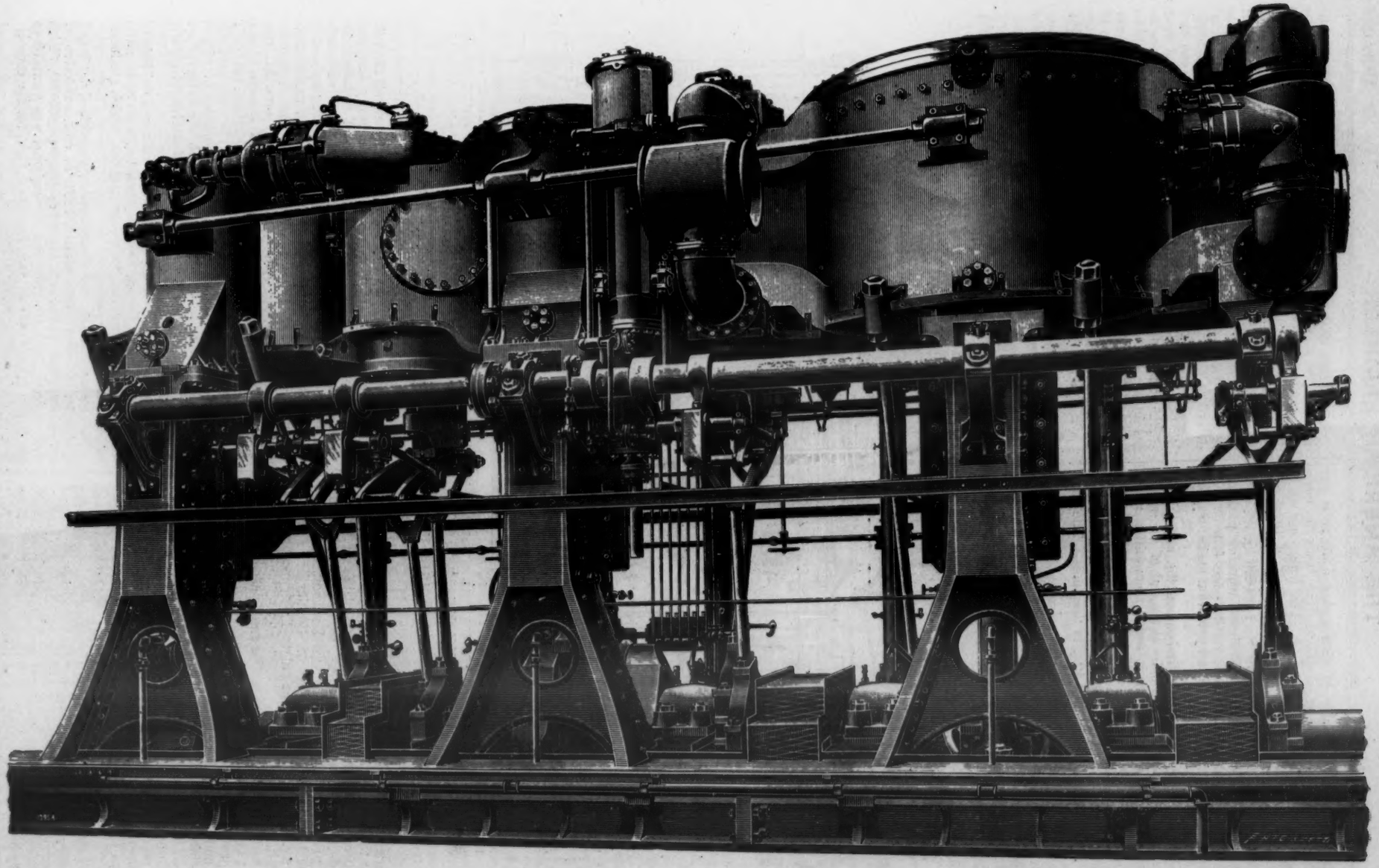
The protective deck, beneath which are placed the magazines, boilers and engines, reaches from end to end of the vessel. At the sides it is 5 ft. below the water-line, sloping upward and inward to 1 ft. above the same line. This deck is 4¼ in. thick on the slopes and 3 in. on the flat over the machinery, being reduced to 3 in. over the entire surface at the ends.

The propelling machinery consists of two vertical, inverted, direct-acting triple-expansion engines driving twin screws; each engine is placed in a separate water-tight compartment, with the high-pressure cylinders forward. The cylinders are 42, 59 and 92 in. in diameter, with 42 in. stroke, and are capable, when making 129 revolutions per minute, of developing, with their auxiliaries, 13,500 H.P.; the main valves are of the piston type, driven by Stephenson links fitted with steam reversing gear and hydraulic controlling cylinders. The piston, crank-shafts and connecting-rods are of forged steel. The condenser shells are of rolled brass with cast-brass heads, and each condenser has 9,495 sq. ft. of cooling surface.

Condensing water is supplied to the condensers by two cir-



ENGINES OF THE UNITED STATES PROTECTED CRUISER "OLYMPIA." FRONT VIEW. (*From "Engineering."*)



ENGINES OF THE UNITED STATES PROTECTED CRUISER "OLYMPIA." REAR VIEW. (*From "Engineering."*)

culating pumps, each capable of discharging 6,750 galls. per minute, and are fitted so as to be able to draw from the main drainage system of the vessel at will. The boilers are six in number, each 15 ft. 3 in. outside diameter, four of them are double ended, 21 ft. 3 in. long, and two single ended, 10 ft. 11½ in. in length. The total heating surface is 28,298 sq. ft., with a grate surface of 824 sq. ft. The designed working pressure is 160 lbs. per square inch. The propellers are four bladed, with the blades bolted to the hub and provision made for altering the pitch.

The main battery is placed entirely upon the main deck, the 8-in. guns being mounted in pairs at the end of the superstructure in barbette turrets, with coned ammunition tubes leading to the protective deck. The 5-in guns are mounted within the superstructure, and so arranged that four can fire ahead and astern, and five on either broadside; these are protected by fixed segmental shields 4 in. in thickness. The auxiliary battery is placed above and below the main battery in positions that afford the greatest range and command possible, a noteworthy feature being the emplacement of the 6-pdr. guns on the deck below the main battery, so that a belt of fire may be maintained all about the vessel without any danger from the interference of the blast of the larger guns, the electric search lights being arranged to light up all portions of this belt.

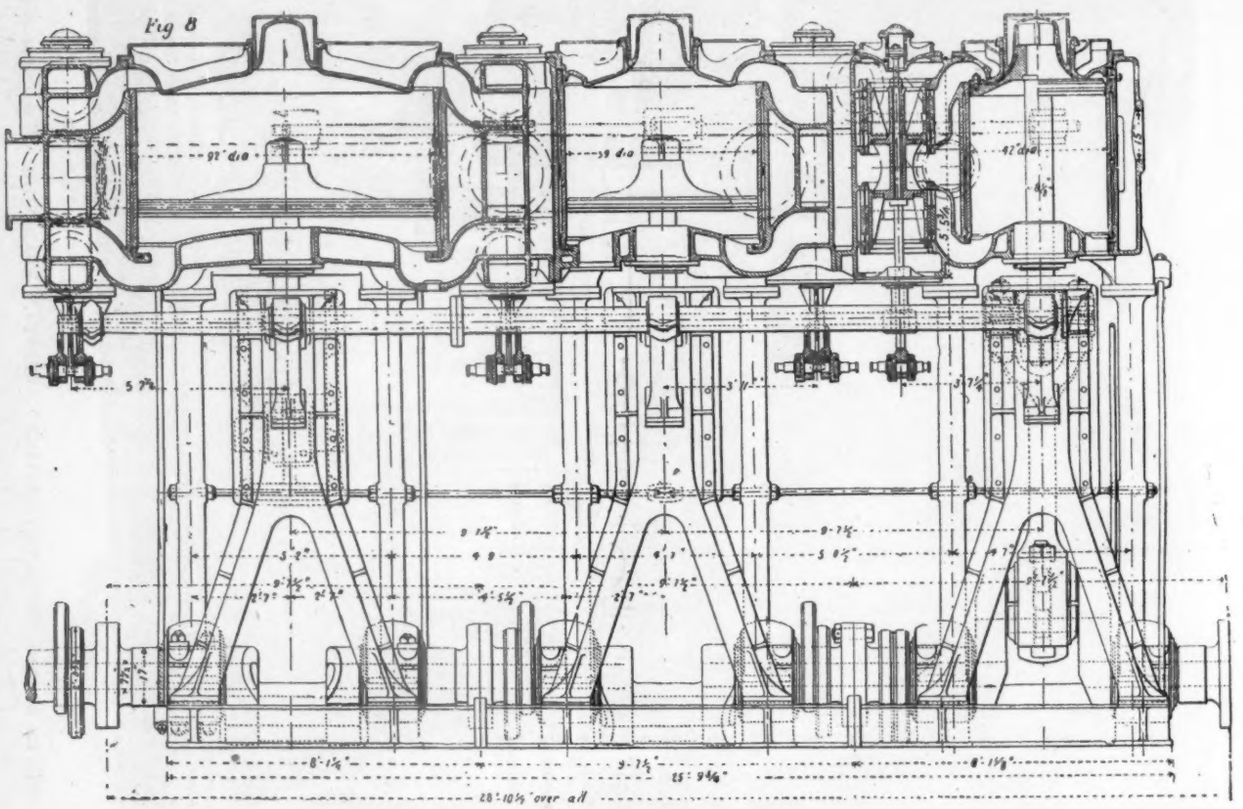
Two masts are fitted each with military and search light tops, sufficient sail being carried to steady the vessel in a sea way. Most approved and modern plants for electric lighting, ventilation, and drainage have been provided.

The principal dimensions are as follows:

Length on load water-line	340 ft.
Breadth molded	53 "
Normal mean draft	21½ "
Displacement, mean draft	5,500 tons
Maximum I. H. P.	13,500
Guaranteed speed on trial	20 knots
Sustained sea speed	19 "
Main battery	4 ft. 8 in. B. L. R. 10 ft. 5 in. R. F. B. L. R.
Secondary battery	14 ft. 6 in. pdr. R. F. guns 6 ft. 1 in. pdr. R. F. guns 4 Gatlings 6 torpedo-tubes.

In addition to the regular armor there are also six torpedo-tubes. The maximum coal capacity put at 1,300 tons and the endurance of the vessel at 10 knots, with full coal supply is 13,000 miles.

It will be seen by an examination of the dimensions which have just been given that the *Olympia* exceeds in size any of her predecessors in the United States Navy. Referring once more to the engines, for the engravings of which we are indebted to *Engineering*, it will be seen that for each of the high-pressure cylinders there is one double-ported valve and two single-ported ones for each intermediate cylinder, and four single-ported for each low-pressure cylinder. The valves in the intermediate and low-pressure cylinders are packed in the usual manner with rings, but the high-pressure valve is not packed. The diameters of these valves are: high-pressure, 18 in.; intermediate, 23 in.; low-pressure, 21 in. The intermediate and low-pressure cylinders are steam packed, and the high-pressure cylinders are provided with liners, all the rubbing parts being made of cast iron. As originally designed, the framing was to have consisted of inverted Y frames at the back and cast steel cylindrical columns in the front, with cross bracing. In the longitudinal elevation of the engine and in the end view these columns are shown as castings as designed. Owing to the difficulty of obtaining these castings, it was determined to substitute built-up Y frames of wrought iron. These are shown in our engraving on the full-page plates, which, being taken from photographs of the engines, naturally presents the work as actually carried out. The cast-steel columns are also replaced in the design by columns of forged steel. The bed plate of I section, on which the columns are supported, is of manganese bronze instead of steel, as originally designed.



LONGITUDINAL SECTION OF ENGINES, UNITED STATES CRUISER "OLYMPIA." (*From "Engineering."*)

The crank-shafts are 16 in. in diameter, with an axial hole of 7½ in. The crank-pins are 17 in. in diameter, with 8½ in. axial holes. The crank shafts are in three sections, which are interchangeable and reversible.

The construction of the *Olympia* was authorized by act of Congress, approved September 7, 1888, to cost, exclusive of armaments and premiums, not more than $1,800,000. Bids were opened June 10, 1890, and the contract was awarded to the Union Iron Works of San Francisco, Cal., for the completion of the vessel by April 1, 1893.

The vessel is now nearing completion.

PROGRESS IN FLYING MACHINES.

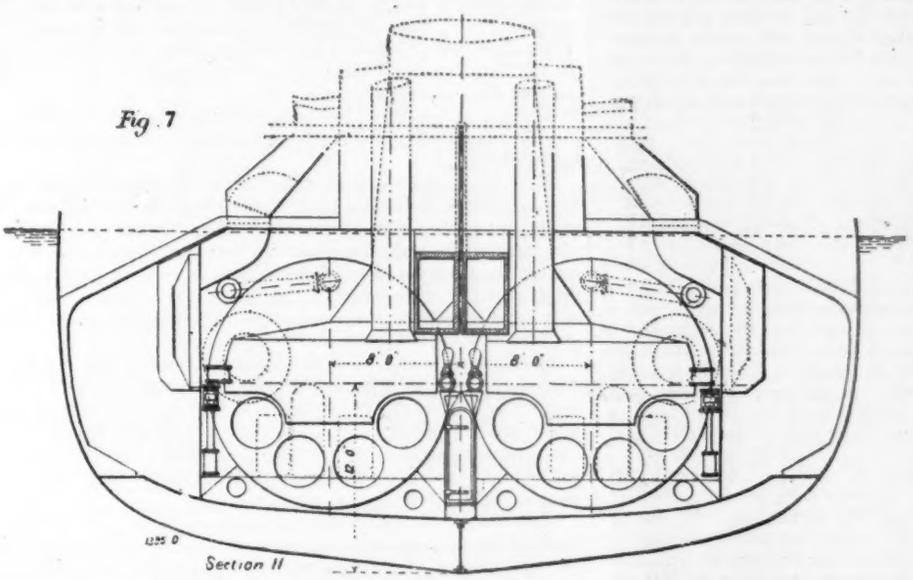
By O. Chanute, C.E.

(*Continued from page 295.*)

At the annual meeting of the American Association for the Advancement of Science, held in Buffalo, N. Y., in 1886, a paper on The Soaring Birds was read by Mr. *Lancaster*, then of Chicago, which paper attracted great interest and attention.

Mr. *Lancaster*, in the hope of surprising the secret of the birds, had the pluck, in 1876, to exile himself to the wilderness of Southwestern Florida, on the Gulf coast, near the Everglades, and there to remain for five consecutive years watching the sailing of the master soarers. He published some of his observations and deductions in the London *Engineer*, in the reports of the Aeronautical Society of Great Britain, and in the *American Naturalist;* but the subject was by no means exhausted, and his description of the phenomena observed was so interesting to the members of the association, few of whom had ever seen a soaring bird at close range, that they demanded to hear more upon a subsequent day.

Fig. 7



UNITED STATES CRUISER "OLYMPIA." CROSS-SECTION AMIDSHIPS.

Unfortunately for Mr. *Lancaster*, upon the latter occasion he attempted to give a mechanical and mathematical explanation of the performances which he had previously so well described, and his theory was so plainly erroneous that he was subjected to harsh ridicule and criticism. He had witnessed some remarkable feats of "Aspiration," he had attempted to reproduce them artificially, but he was clearly wrong in his expounding of the mystery, and his critics did not properly discriminate between the statements of observed facts and the attempted explanation.

The principal issue, however, was made concerning some attempts to imitate soaring action, which Mr. *Lancaster* claimed to have successfully made in Florida, and which he unwisely declined to exhibit at Buffalo. He had described them in his paper as follows:

I constructed floating planes which, for lack of a better name, I have termed "effigies," and which are an example in point. I have made scores of them. They would draw into the breeze from the hand and simulate the soaring birds perfectly, moving on horizontal lines or on an inclination to a vertical. They would float in the best winds with neither ledge, rough front surface nor rear curve, if very nicely adjusted; but one of this construction I never induced to pass beyond the limits of vision, as the equilibrium was so very delicate that a little inequality in the wind current would capsize it.

There is every probability that such an experiment would invariably fail if tried in any but a perfectly steady sea breeze, an inflowing current of air with peculiar conditions; but it does not follow that the action described is impossible, for if we presume that current to have an upward trend (and the writer knows, of his own knowledge, that such upward trends are not rare in sea breezes), we can readily see that an aeroplane, tipped forward so as to point below the horizon, may be both sustained and "aspirated," or possess a forward component of pressure, so that it may advance against the wind, and rise, at the same time, like the kite of M. *Myers*.

The equilibrium is, of course, excessively delicate, and hence the requirement for a sea breeze: for a local homogeneous mass of air flowing from the water over the land to replace the rising quantity heated by the sun; but it is erroneous to suppose that the experiment described by Mr. *Lancaster* involves a mechanical impossibility. It is, doubtless, difficult to repeat it successfully, because it requires a combination of peculiar conditions; but the soaring birds are daily performing the feat, and apparently in horizontal winds.

In order that those who are favorably circumstanced may test the matter experimentally, the following description of the device is copied from a paper of Mr. *Lancaster*, published in 1882:

Take a stick of wood 1 in. square and 18 in. long, and point one end. Slit the other end 3 or 4 in., and insert a piece of stiff cardboard 6 in. wide and 1 ft. long. This will represent the body and tail of the bird. Fasten on both sides near the pointed end a tapering stick 2 ft. long, with the outer ends slightly elevated, and fasten to these and the body a piece of cardboard 10 in. wide and 2 ft. long. Have the tail vertical instead of horizontal, as in the bird. Round off the outer rear corners of the wings for 3 or 4 in. The imitation of the natural bird is now complete. There is no need of exactness, as the air you are to try it in will be an unknown quantity, and it may just suit the shape you make. An indispensable part is now to be added, which is to preserve the equilibrium and is not used by the natural bird. A tapering stick, say 1½ in. wide ⅜ in. thick at the top, ⅜ in. square at the other end, and 18 in. long is used. This piece is to be securely fastened by a small bolt through the upper end of the body piece about 5 in. from the front end. It must be capable of adjustment by allowing the lower end to swing front and back through say 40°. To the lower end is fastened a muslin bag which will hold 2 lbs. of shot. Expose the effigy to a breeze of from 3 to 20 miles an hour from as high a situation as it is possible for you to obtain, by holding it by the pendant stick near the body. Adjust the weighted stick forward or back, and add or subtract shot until the effigy has a tendency to spring from your hand against the current of air, when it may be released at a moment of greatest steadiness of breeze.

I have made hundreds of these toys, with all kinds of success, but have never yet succeeded in getting one to travel beyond the limits of vision. They have proceeded directly against the breeze for 500 yards, and obliquely, up or down, or to right or left, within those limits, when they would lose their balance and come down. Sometimes almost any kind of one that was presented to the air would float creditably, while at others none would succeed. The pendant weight for maintaining equilibrium, though the best I have ever devised, is far too sluggish for perfect work. The momentum of this weight prevents the best results, for, if a succession of puffs of wind upon the same wing should occur quickly together, the weight would swing far enough, in obedience to the impulse given, to capsize the effigy. Such a succession of puffs is sure to occur, sooner or later, at each trial. These toys operate long enough, however, to prove the purely mechanical character of flight, and serve to materially strengthen the theory.

The writer may confess that he has tried this experiment several times under special instructions furnished by Mr.

Lancaster, but that he has never succeeded in floating one of these "effigies" so that they would advance against the wind. Others have, to his knowledge, tested the matter, and had no better success, yet it is not rational to say that the feat is impossible, for it is very clear that if the wind have an ascending trend, and the "effigy" be slightly tipped toward the front, the horizontal component of air pressure will drag it forward, while the vertical component will sustain or elevate it, as already explained. It is probably because of the uncertain prevalence of ascending trends that Mr. *Lancaster* complains that sometimes almost all these toys would succeed in simulating soaring, and sometimes none at all.

In 1888 Mr. *Lancaster* moved to Colorado, where he has been experimenting with a view to the solution of the problem of soaring flight; and in the *American Naturalist* for September, 1891, he gave an account of some of his experiments, with the conclusions which he deduced therefrom. The following extract contains an account of a remarkable occurrence. He says:

I can produce true soaring flight in natural wind, with a plane exceeding 2 lbs. to a square foot of surface, whenever I wish to do so and can obtain wind strong enough for the purpose. During the past three years I have made about 50 planes [aeroplanes?] of various shapes and sizes, and from 25 lbs. to 400 lbs. in weight. These planes are not set free in wind, but used in the experimental cases above described, but with rigid rods in place of the parallel wires. These rods run in large rings and have a cross-head at their outer ends allowing the plane to run to the front until its edge rests against the rings. In the best trial the parallel [with the plane?] component is neutralized at 10° from horizontal, far exceeding my expectations derived from observations of the birds, their angle of obliquity being rarely over 5°.

On a few occasions these planes accidentally escaped me in time of highest wind, and were ruined at once for all purposes excepting firewood, in each case being a loss of two or three months' work, and playing havoc with my finances. One that I valued particularly plunged to the front in a violent blast of wind with force sufficient to tear out the rings. It rose into the air, gradually higher and higher, until an elevation of at least 3,000 ft. was attained, when some part of the device giving away, it lost equilibrium and plunged through the air, striking the earth about 2½ miles from the starting-point, and 1,000 ft. higher than that locality. Another mile would have carried it to the summit of the Flat Top Mountains. It was in the air about three hours, and I walked beneath it during its flight. Its course was directly against the highest wind I have experienced during my residence here At times it did not progress, but went higher. It weighed 110 lbs., and had been well balanced for experimenting on surface manipulation. There was no lesson taught in this flight, the birds having been doing the same thing for a long time. It was an interesting spectacle to look at; so is a large bird in the same act. I presume Mr. Darwin's provisional solution would apply to this plane as well as to the condors; but I am trying to explain the actual mechanical activity of both.

The best effects produced were with a plane of 400 lbs. weight and 80 sq. ft. of surface. In a wind that would be rightly termed a gale, arising about midnight, this plane was thrown about 7° from horizontal. It ran to the front against the rings at 10°, where the entire parallel component was neutralized, and at 7° it hugged the rings with a force that required a backward pull of 15 lbs. to detach it.

This plane would make a splendid navigator, and I would have no hesitation in trusting myself to it, when steering, equilibrium and alighting or stopping items had been worked out. I mean to say that it would navigate wind. I am now just entering on a course of experiments in calm air.

This very interesting case of "aspiration" may have been produced by the same cause as in the case of M. *Myers's* kite—*i.e.*, an ascending trend of wind; but certainty concerning this depends upon the shape of the surface. Mr. *Lancaster* writes of it as a "plane;" but as he mentions also the "front ledge" and the "rear curve," the surface operated upon by the wind was probably a more or less compound surface, for which there is no specific name, but which may be described as an aeroplane. If it was shaped like those of the soaring birds, then "aspiration" might occur with a horizontal wind, but the equilibrium would be very unstable, and, as Mr. *Lancaster* points out, the steering, alighting, and stopping would be the important points to work out.

Among the most systematic and carefully conducted series of experiments that have ever been made in the direction of artificial flight are those of Herr *Otto Lilienthal*, of Berlin, Germany, a mechanical engineer and constructor, and a prominent member of the German Society for the Advancement of Aerial Navigation.

The general position that he maintains, and in pursuance of which he has made his more recent experiments, is that bird flight should be made the basis of artificial flight. Dexterity alone, as he maintains, invests with superiority the native denizens of the air, and, therefore, man, if he possessed sufficient skill, might participate in flight. He evidently believes, like M. *Mouillard*, that for the soaring birds, ascension is the result of the skillful use of the power of the wind, and that no other force is required; and, therefore, that to imitate them no engines or other external sources of power are needed, but that all the necessary apparatus consists of properly constructed sustaining surfaces skillfully operated.

Herr *Lilienthal*, instead of first flying at conclusions, began by a systematic analysis of the problem, verified by experiments, which latter were carried on by himself and his brother, *G. Lilienthal*, during a period covering nearly 25 years, and he published in 1889 a book on "Bird-Flight as the Basis of the Flying Art," * in which he gave the result of his investigations.

From a review of this remarkable book in the *Aéronaute* for January, 1892, the following account of its contents has been prepared.

Herr *Lilienthal* seems to have begun by observing the sailing of various sea birds following vessels at sea, and of the stork, an expert soarer, which inhabits Germany; he drew the conclusion that *plane* surfaces present undue resistance, and that success in artificial flight is only to be expected from concavo-convex sustaining surfaces; a belief which, as we have already seen, was also entertained by *Le Bris*, *Beeson*, *Goupil*, *Phillips*, and others.

He declares that the laws of air resistances and reactions which, unfortunately, are as yet but imperfectly known, form the whole basis for the "technique" or actual performance of flight, and that the shapes and methods of birds so completely utilize these laws and offer such appropriate mechanical movements that failure must follow if they be discarded.

Herr *Lilienthal's* experiments were in great part directed toward an investigation of the resistances and reactions of air, and the power necessary for flight. One of these consisted in suspending himself from a spar projecting from a house and operating a set of six wings opening and closing like concave Venetian blinds, through which he measured the lifting effects of wing strokes performed with the muscles of the legs, so that the step of each foot would produce a double stroke of the wing. The weight of the operator and wings combined was 176 lbs., and they were counterweighted with 88 lbs. suspended to a rope passing over two pulleys. With some practice he was enabled, by operating the wings with the pedals, to lift himself 30 ft. from the earth, thus proving that he obtained, through his mechanism, wing power sufficient to lift the remaining 88 lbs—a very excellent performance, and much in excess of most of those hitherto described in this review of Progress in Flying Machines.

This and other experiments, together with a consideration of the power to be obtained from the wind, convinced him that artificial flight was accessible to man, aided by considerably weaker motors than have generally been thought indispensable, and, indeed, under favorable circumstances of wind, with no motor at all.

Herr *Lilienthal*, therefore, carefully analyzed the shapes and methods of the living birds and the exact proportions of their concavo-convex surfaces. He went into this in detail, and finally formulated in his book the following conclusions:

1. The construction of machines for practical operation in nowise depends upon the discovery of light and powerful motors.

2. Hovering or stationary flight without forward motion cannot be compassed by man's unaided strength. This mode of

* "Der Vogelflug als Grundlage der Fliegekunst," Von Otto Lilienthal, Berlin, 1889.

flight would require him to develop, under the most favorable circumstances, at least 1.5 horse power.

3. With an ordinary wind man's strength is sufficient to work efficiently an appropriate flying apparatus.

4. With a wind of more than 22 miles per hour, man can perform soaring or sailing flight by means of adequate and appropriate sustaining surfaces.

5. A flying apparatus, in order to operate with the greatest possible economy, must be based, both in shape and proportion, upon the wings of the large, high-flying birds.

6. The sustaining wing surface may be from 0.49 to 0.61 sq. ft. per pound of weight.

7. Sufficiently strong apparatus can be built of willow frame and stretched fabric, so as to provide a sustaining surface of 107 sq. ft., with a weight of about 33 lbs.

8. A man provided with such an apparatus would have an aggregate weight of 198 lbs., and would then have 0.55 sq. ft. of sustaining surface per pound, or about the proportions of large birds.

9. Experiment must determine whether the most advantageous shape be that of birds of prey and of waders, with

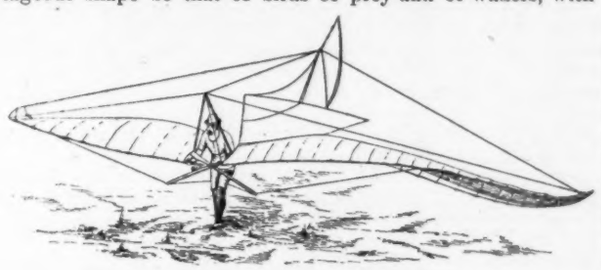


Fig. 73.—LILIENTHAL—1891.

broad wings and spread out primary feathers, or that of sea birds, with narrow wings tapering to a point.

10. If the broad wing be adopted, the wings of an apparatus with 107 sq. ft. of sustaining surface would needs be of 26.25 ft. spread, with a maximum width of 5.25 ft.

11. If the narrow wing be adopted, a surface of 107 sq. ft. would need a spread of 36 ft. with a maximum width of 4.60 ft.

12. The application of an additional bearing surface, as a tail, is of minor importance.

13. The wings must be curved in transverse section so as to be concave on the under side.

14. The depth of flexure should be one-twelfth of the width, in order to correspond with that of birds' wings.

15. Experiment must determine whether greater or lesser flexure will prove preferable for larger wing surfaces.

16. The framing and spars of the wings should be at the front edge so far as possible.

17. A sharp cutting edge should terminate this framed front edge if possible.

18. The flexure should be parabolic, the greater curvature being to the front and flatter to the rear.

19. The best shape of flexure for large surfaces must be determined by experiment; also what preference is to be given to those shapes which produce the least resistance to forward motion at flat angles of incidence.

20. Construction must be such as to admit of the rotation of the wing upon its longitudinal axis, which rotation will best be obtained, in whole or in part, by the pressure of impinging air.

21. In flapping flight the inner wide portion of the wing should oscillate as little as possible, and serve exclusively in sustaining weight.

22. The propulsion to maintain speed should be obtained by up-and-down beats of the wing tips or of the primary feathers, the forward edge being depressed.

23. In flapping flight the widest portion of the wing must also co-operate in the upstroke in order to sustain weight.

24. The wing tips should encounter as little resistance as possible on the up stroke.

25. The down stroke should be in duration at least six-tenths of the time occupied by the double stroke.

26. The wing-tips alone need oscillate; that portion of the wing which merely sustains may remain rigid, as in soaring flight.

27. If only the wing-tips oscillate they should not be articulated, as this would dislocate them; moreover, the transition to the up stroke should be as gentle as possible.

28. In order to beat a pair of wings, man must employ his extensor muscles, and this not simultaneously, but alternating each side, so that each stroke of the foot shall produce a double stroke of the wings.

29. The up stroke may be produced by the pressure of the air under the wings.

30. The energy of the air pressure under the wings may be partly stored in a spring so as to restore the power on the down stroke, and thus produce economy in work done.

Such are the principal considerations which must be observed in the application of the theories herein expounded. . . .

Governed by these considerations, equipped with much preliminary experiment and analysis, Herr *Lilienthal* put his theories and conclusions to practical test, in the summer of 1891, by undertaking a series of experiments with a pair of curved wings designed for soaring alone—that is, to serve as sustaining surfaces and not for flapping or propulsion.

The following account of these experiments has been furnished by Mr. *George E. Curtis*, of Washington, D. C., who has also obtained from Dr. *C. Kassner*, of the Meteorological Institute at Berlin, the very graphic photographs from which the engravings have been made.

The *Lilienthal* apparatus is shown in fig. 73, and consists of a pair of extended bird-like wings, incurvated from front to back on parabolic lines, and sinuous in the direction of their lengths. The area of sustaining surface, as at first constructed, was 107 sq. ft., but it was diminished in the course of numerous changes and remodellings to 86 sq. ft. There was, as will be observed, a horizontal tail and a vertical rudder or keel. The framework was made of willow, and covered with sheeting fabric. The weight of the whole apparatus, without the operator, was 39.6 lbs.

In order to become accustomed to the management of these artificial wings, Herr *Lilienthal* first practised in his garden. Here he had a spring-board, toward which he ran for a distance of about 26 ft.; and with the velocity thus acquired, together with the reaction of the spring-board, he launched himself into the air, where he could learn to operate and to manage the wings.

After these preliminary experiments had given him dexterity and facility in the management of the apparatus, he betook himself to a hilly region in the suburbs of Berlin, and there practised soaring flight in natural winds of moderate velocities. The plan, of course, consisted in first running against the wind, and thus deriving therefrom the necessary sustaining air pressure.

Having selected a hill whose downward inclination faced the prevailing wind, he ran along the summit straight toward the wind, until a sufficient velocity was attained at the brow, where he was carried into the air and landed safely at the foot of the hill, having sailed a distance of 65 to 82 ft.

When the wind velocity became greater than 11 to 13 miles

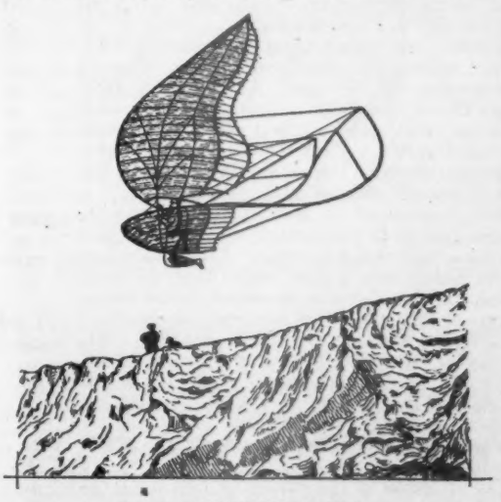


Fig. 74.—LILIENTHAL—1893.

per hour, the management of the apparatus became exceedingly difficult, and Herr *Lilienthal* advises an experimenter not to venture to leave the ground under such circumstances, unless he has attained, through long practice, a considerable degree of dexterity in manœuvre.

The results attained in the practice of the season of 1891 were sufficiently encouraging to warrant the further prosecution of these experiments in the following year; but they disclosed a number of points to which additional attention

needed to be given in order to overcome the practical difficulties in imitating the birds. These points related to a better adjustment of the center of gravity, to methods for obtaining greater stability, and to the mode of management of the apparatus when the wind blew more rapidly than 11 to 13 miles per hour.

In the issue of the *Zeitschrift für Luftschiffahrt* for November, 1892, Herr *Lilienthal* published an article on "Soaring and its imitation," in which he gives a brief account of his experiments in the summer of 1892, from which the following abstract has been prepared :

Many theories have been proposed to explain soaring. My own explanation is based upon the advantageous relations of air resistances incident to the use of slightly curved wing surfaces (as I have demonstrated) and upon the gently rising trend of air current which I have found to prevail.

A flying apparatus which has the same proportions as those of a good soaring bird and is of sufficient size to carry a man can scarcely be held fast by three or four men together when exposed to a brisk wind. When we look at the safe and quiet sailing of the birds it almost seems as if some undiscovered mechanical principle were at work, some feature in the elastic properties of air or in the elastic curvature of the feathers which accounts for the mystery of sailing flight ; but my experiments have taught me that there is no mystery, and that the same mechanical science which has explained the theory of the steam-engine and followed the orbits of the planets is adequate to explaining the operations of soaring flight.

Dexterity alone, in my opinion, invests the native inhabitants of the air with superiority over man in that element. . . . Inasmuch as continuous soaring with large wings in high winds can terminate in scarcely anything but the destruction of the foolhardy fellow who may first attempt the experiment without previous practice, I first undertook last year to gain some expertness with a smaller apparatus and in moderate winds. In spite of my caution the wind several times played the mischief with me. Even with only 86 sq. ft. of sustaining surface, I was several times tossed up into the air by unexpected gusts of wind, and but for the circumstance that I was able to release myself quickly from my apparatus, I might have had a broken neck instead of the sprains in feet or arms which always healed in a few weeks.

Almost every Sunday, and sometimes on week days, I went out to practise on the hill between Grosskreutz and Werder. A mechanic, Herr Hugo Eulitz, the maker of my apparatus, went with me, and each practised alternately while the other rested. Thus we obtained dexterity in gliding down on the air and in landing at the foot of the hill without mishap.

Herr Kassner, of the Meteorological Institute, was so kind as to photograph me in the air, and has thus enabled me to exhibit to the members of the society how I sailed right over the head of the miller of Derwitz (in whose barn I stored my apparatus) and of his esteemed poodle dog.

Equipped with the experience gained in 1891, I this year attempted to soar with wings measuring 172 sq. ft. in surface. My apparatus weighed 53 lbs., and my own weight is 176 lbs., so that the whole was 229 lbs. Each square foot of surface, therefore, sustained $229 \div 172 = 1.33$ lbs.

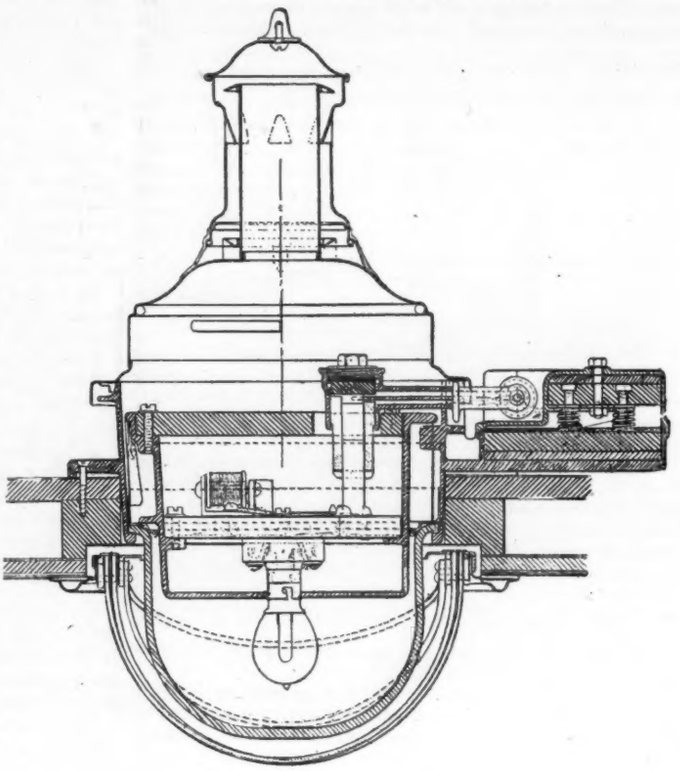
The up thrust of the wind (the lift) upon the wing surface is perhaps half as much as the pressure of the same wind upon the same surface if turned perpendicular thereto.* Now, as the apparatus therefore needs to sustain it a wind producing a pressure of $1.33 \times 2 = 2.66$ lbs. per square foot, we see that (by ordinary tables of wind pressures) it must blow at a velocity of about 23 miles per hour.

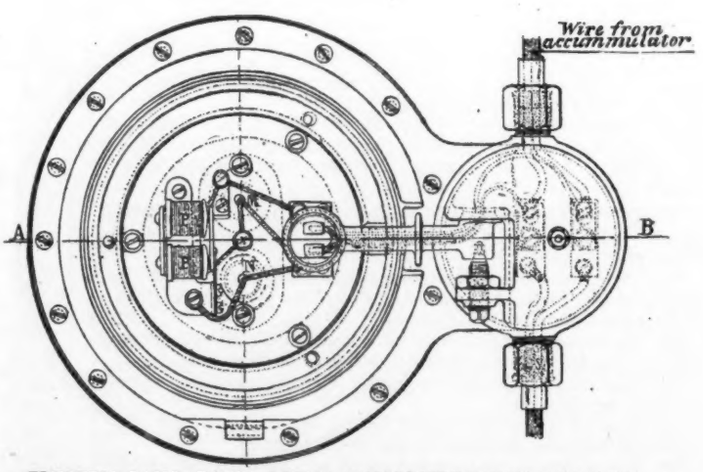
I have, however, been very cautious about exposing myself to such a wind with this large apparatus ; and in such high winds have used smaller surfaces for my sailing practice.

This year I selected a locality between Steglitz and Südende. It had, however, the disadvantage that only westerly starts were possible. Herr Kassner has again taken instantaneous photographs of my apparatus, which have been laid before the society (fig. 74). The strongest winds in which I practised had a velocity which I estimated at between 15 and 16 miles per hour. By running I obtained an additional velocity of 7 miles an hour, making the total relative velocity 23 miles an hour, which was required for soaring. Under these circumstances the first part of my flight was almost horizontal, and the alighting was always a gentle one. . . . Each apparatus had a vertical and horizontal tail, without which it is impracticable to practise in the wind. In conclusion, I will remark that sailing flight near the earth's surface must be much more difficult than at greater heights, where the wind blows more regularly, while every irregularity of the ground at lower levels starts whirls in the air.

(TO BE CONTINUED.)

* Lilienthal, "Der Vogelflug als Grundlage der Fliegekunst," Tafel VII.





ELECTRIC LAMP, PARIS, LYONS & MEDITERRANEAN RAILWAY.

ELECTRIC LIGHTING ON THE TRAINS OF THE PARIS, LYONS & MEDITERRANEAN RAILWAY.

In our issue for March we gave a short description of the method of electric car lighting in use on the Northern Railway of France, supplementing the same in our April issue by a description of the system in use on the Jura-Simplon Railway.

We now reproduce from *L'Electricien* a description of the system of lighting which has been brought on the Paris, Lyons & Mediterranean Railway.

The Paris, Lyons & Mediterranean Railway Company are making a test of electric lighting on 50 first-class four-compartment passenger cars. A portion of these cars are already completed, and the whole will be put into regular service with the new method of lighting, the plant for generating electricity for charging the accumulators being located at the Paris station, and it will be very soon completed. This application of electric lighting has been decided upon by the company in consequence of the numerous experiments which have been carried out during the last three years with primary and secondary batteries, the latter of which will be used for the new work.

The accumulators adopted are of the Tommasi multitubular system, with electrodes protected by a perforated envelope of celluloid. Each cell carries 26.5 lbs. of electrodes.

Each car is provided with a battery of 12 cells set up under tension and divided into four groups of three cells each. Each group is placed in a tight box of three compartments, which is in turn placed in a sheet metal chest lined on the inside with wood, all the movable boxes being interchangeable.

The chests are fastened one on either side of the car just opposite the pedestal brace. They are provided with a hinged horizontal door which turns down so that the tight box containing the three elements can be very easily removed or put in position. The connections are made automatically by means of contact points in the case and the box. For this purpose the latter has brass springs which are permanently connected with the wiring of the car; the poles of the group of the three cells end in two metallic pieces of an alloy of antimony and lead fixed to the case and projecting so as to turn against the springs, thus putting the group into the circuit when the case is set into the box. Insulated wires enclosed in iron tubes serve to make connection between the contact springs of the four boxes of the car. The tube containing the insulated wires runs along close to the frame and beneath the body of the car, and comes together at the ends of the car, whence they run to the lighting commutator. Switch connections are used to make and protect the connections between the insulated wires and the springs of the boxes. Incandescent lamps of 10 candle power have been adopted, and a difference of potential limited to 20 volts will be used. Each of the four compartments of the car is lighted by one of these lamps. The lamps are of the ordinary model, and are so arranged that oil gas can readily be substituted for the electric lighting in case the latter should for any reason become useless, and that, too, without disconnecting any of the apparatus. In order to do this the electric lamps are mounted upon a movable support which can be readily substituted for an oil lamp or *vice versa*.

The current is brought to the lamp through a bi-polar lever, which is usually turned down beneath the cap of the lamp, and which it is merely necessary to lift up in order to very easily remove the whole of the support. This support carries two incandescent lamps, only one of which is usually lighted; the second serves as a reserve lamp, and is lighted automatically if the first should become accidentally extinguished. This automatic arrangement is accomplished by an electric magnet, *P*, fig. 1.

If we take the average consumption of each lamp as 38 watts, the battery of accumulators can feed four lamps of a car for about 35 hours. The accessory apparatus consists of three parts: The lighting commutator, the rheostat, and the meter. The lighting commutator into which the two conductors come from the batteries possesses no special features. It is arranged in the same way as the main cock of cars lighted with oil gas. It is controlled by a handle sliding along end supports and into the intermediate supports.

The rheostat, which is placed in the lamp circuit, is to compensate during the early part of the discharge for the excess of voltage of the battery over what is necessary for the normal illumination of the lamps. By connecting it with the indications furnished by the meter, it is put out of circuit when the lighting has been in operation for 17 hours—that is to say, at about half of its normal duration.

The meter is constructed on the Aubert system, which is the one which has already been adopted on the Jura-Simplon Railway. The dial is divided into 35 divisions corresponding to the 35 hours, during which the batteries are capable of operating. The pointer is so arranged that it moves from division 35 to division 0, and consequently indicates the number of hours lighting which the battery is still capable of furnishing. This meter is placed in the same position as the pressure gauge of the cars which are lighted with oil.

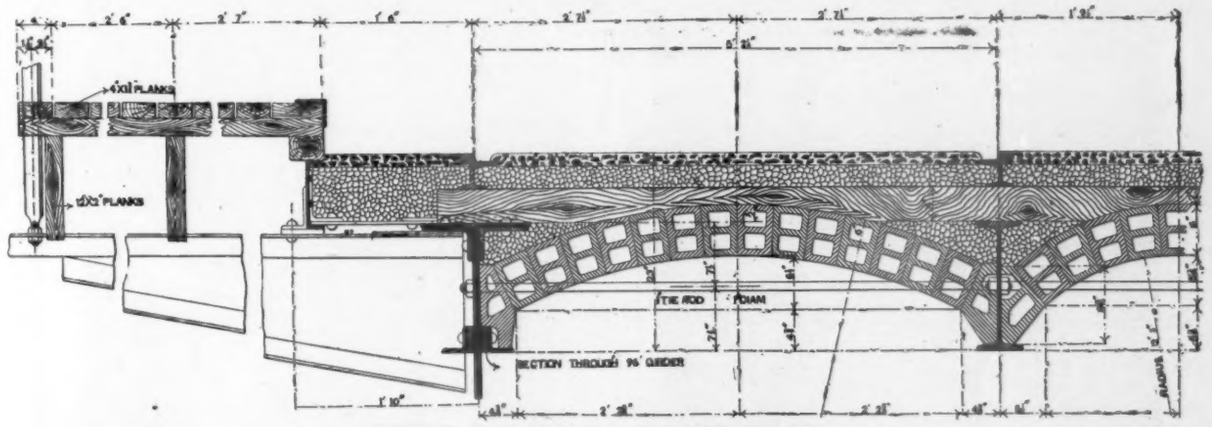
Wiring for the lamps is identically the same as that for the accumulators, and is contained in two insulated cables enclosed in an iron tube. These two cables, starting from the commutator, pass through the meter, the rheostat, and run to the roof of the car, where they enter the switch boxes that are placed near each lamp, and within which the connection between the wires from the lamps and the main line is made.

The apparatus of each first-class car, therefore, consists of eight incandescent lamps, four of which are auxiliary lamps, the battery accumulators of four nests of cells, which weigh 505.7 lbs., and is composed of:

Electrodes alone, 346.9 lbs.

Boxes and cases, 158.8 lbs.

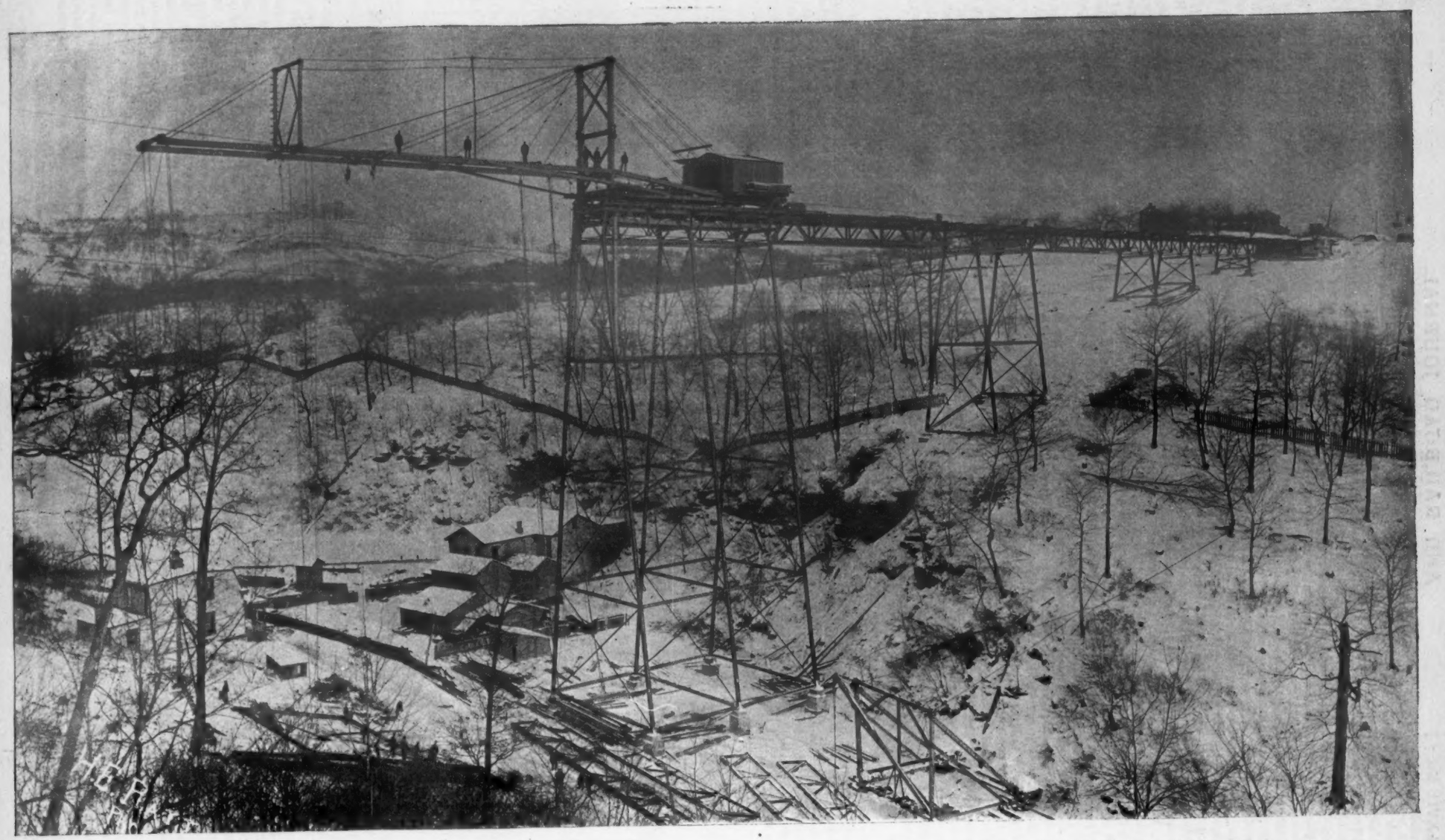
The rest of the apparatus, comprising the main box for carrying four cases of accumulators, the wiring commutator, rheostat, meter and lamps, represent a total weight of about 1,098 lbs. The total capacity of the battery of four nests of cells is about 5,600 watts, which represent 36 hours of lighting for the whole four lamps, admitting that each has a consumption of 38 watts per hour.



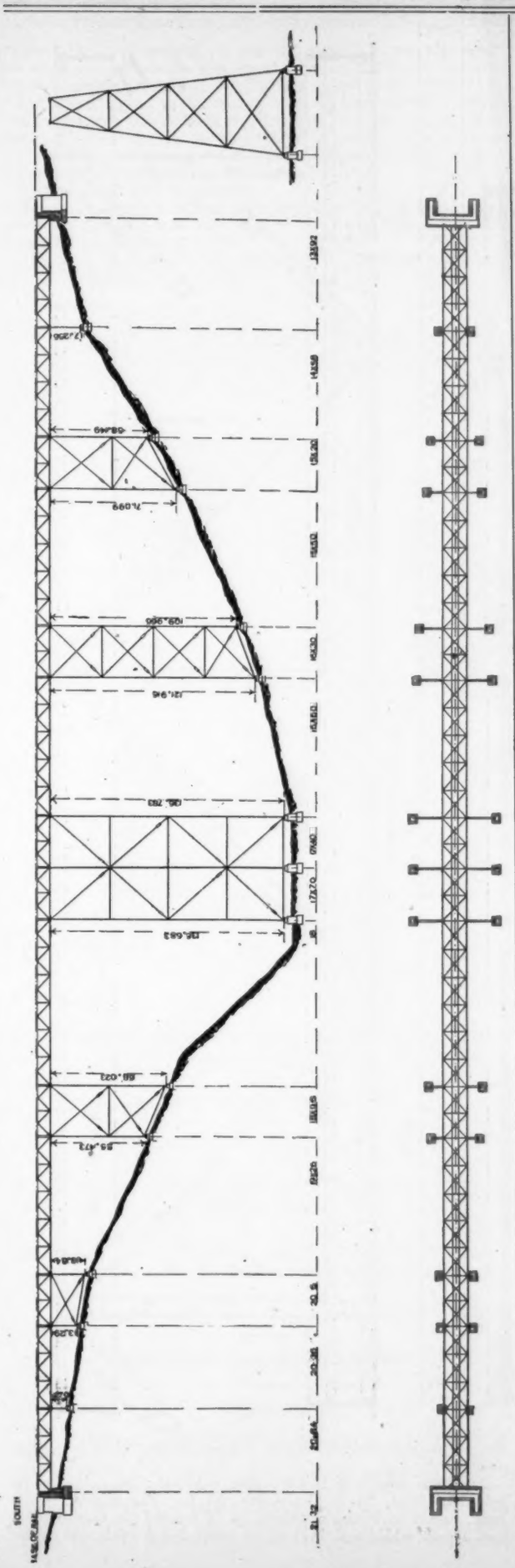
SECTION OF FLOOR OF JACK'S RUN BRIDGE.

THE CAOUTCHOUC INDUSTRY OF ASSAM.

THE Calcutta *Englishman* states that a change has been recommended in the present regulations affecting the sale of caoutchouc in the Government forests of Assam. Owing partly to the reckless method of working adopted by contractors and their agents, and partly to the depredations of illicit tappers, there has been a serious falling off in production. The unprotected and inaccessible situation of most of the rubber tracts enables the neighboring hill tribes to illicitly tap the trees and import the rubber into Assam free of duty as foreign produce. It is stated that the Government forests on the frontier are overrun with foreign rubber tappers, who come down systematically by night in separate gangs, each under a sardar, and tap nearly all the trees growing within a few miles of the border. The leases to contractors have, however, now expired, and a scheme for the better protection of the forests is now under consideration. On the average about Rs. 30,000 has been derived annually from this source during the past 10 years, and under an effective system of administration the revenue could doubtless be largely increased.



JACK'S RUN VIADUCT, ON THE PITTSBURG, FORT WAYNE & CHICAGO RAILROAD. BUILT BY THE SCHULTZ BRIDGE & IRON CO., OF McKEE'S ROCKS, PA.



JACK'S RUN VIADUCT.

THE borough of Bellevue is located on the steep northern heights of the Ohio River, over 200 ft. above the river, having a station at the Pittsburg, Fort Wayne & Chicago Railroad in the valley 6 miles distant from Pittsburg.

For the ascent to the hilltop seven years ago a passenger elevator was built, which lands its passengers a good distance from the principal part of this thriving place.

The increasing necessity for close communication of this suburban borough with the cities of Allegheny and Pittsburg would have resulted long since in an extension of Pittsburg's electric car lines, had it not been for the steep valley of Jack's Run at the boundary line of the city of Allegheny.

Last year California Avenue was extended from Allegheny to the edge of this valley to a point about half a mile distant from the place where Jack's Run empties into the Ohio River; at the same time the Pleasant Valley Street Railroad Company laid their tracks along this avenue to Jack's Run, and decided to extend their line still further to the central part of Bellevue and Avalon, for the accommodation of their citizens, and in consequence to connect both edges of Jack's Run valley by a steel viaduct more than 700 ft. long and over 150 ft. high.

This Company had a line surveyed and adopted the plan of the Schultz Bridge & Iron Company at McKee's Rocks, Pa., to which company they awarded the contract for building this bridge.

The viaduct has six spans of 30 ft., two spans of 48 ft., two spans of 64 ft., three spans of 80 ft., and one span of 96 ft.

The girders of these spans have a uniform height of 8 ft., and support a roadway of 17 ft. between curbs and two sidewalks of 5 ft. The track rails are fastened to oak cross-ties 4 in. high; these rest upon stringers or upon girders acting as such, so that the distance center to center of girders is 14 ft., which is also the width center to center of bent posts at top of bents, from where the posts spread toward the ground, with a batter of 1½ in. to the foot. All floor, girder and bent connections are riveted; only the tower rods are pin connected.

The 30-ft. girders bridge the tower spans, which have from one to four stories; at the deepest place of the valley a double tower is located.

The strains in the structure have been based on the following assumptions:

Dead load:	Roadway floor,	60	lbs.	per	square foot.
	Sidewalk "	15	"	"	"
	Stringers	100	"	lineal	" of span.
	Floorbeams	100	"	"	" "
	30-ft. girders	160	"	"	" "
	48-ft. "	240	"	"	" "
	64-ft. "	320	"	"	" "
	80 ft. "	400	"	"	" "
	96 ft. "	480	"	"	" "

Live load: 80 lbs. per square foot of roadway and sidewalk, respectively, electric cars of 12 tons, 20 ft. long, 6 ft. wheelbase.

Wind pressure for top laterals: 300 lbs. per lineal foot of span, 150 lbs. of these treated as moving load.

Wind pressure for trestle towers: 400 lbs. per lineal foot of span and 150 lbs. per rising foot of bent.

For the proportioning of section unit strains have been taken is follows:

Tension on lateral bracing, 15,000 lbs. per square inch; on bottom flange at riveted girders, 14,400 lbs. per square inch, net section; on fiber most strained in I-beams, 16,000 lbs. per square inch; on bottom chords and diagonals, 11,100 lbs. per square inch for live load, and 22,200 lbs. for dead load.

Compression in girder members:

P, 8,750, $50\frac{1}{r}$ for live load strains;

P, 17,500, $100\frac{1}{r}$ for dead load strains;

P, 17,100, $\frac{1}{r}$ in posts and struts of bents;

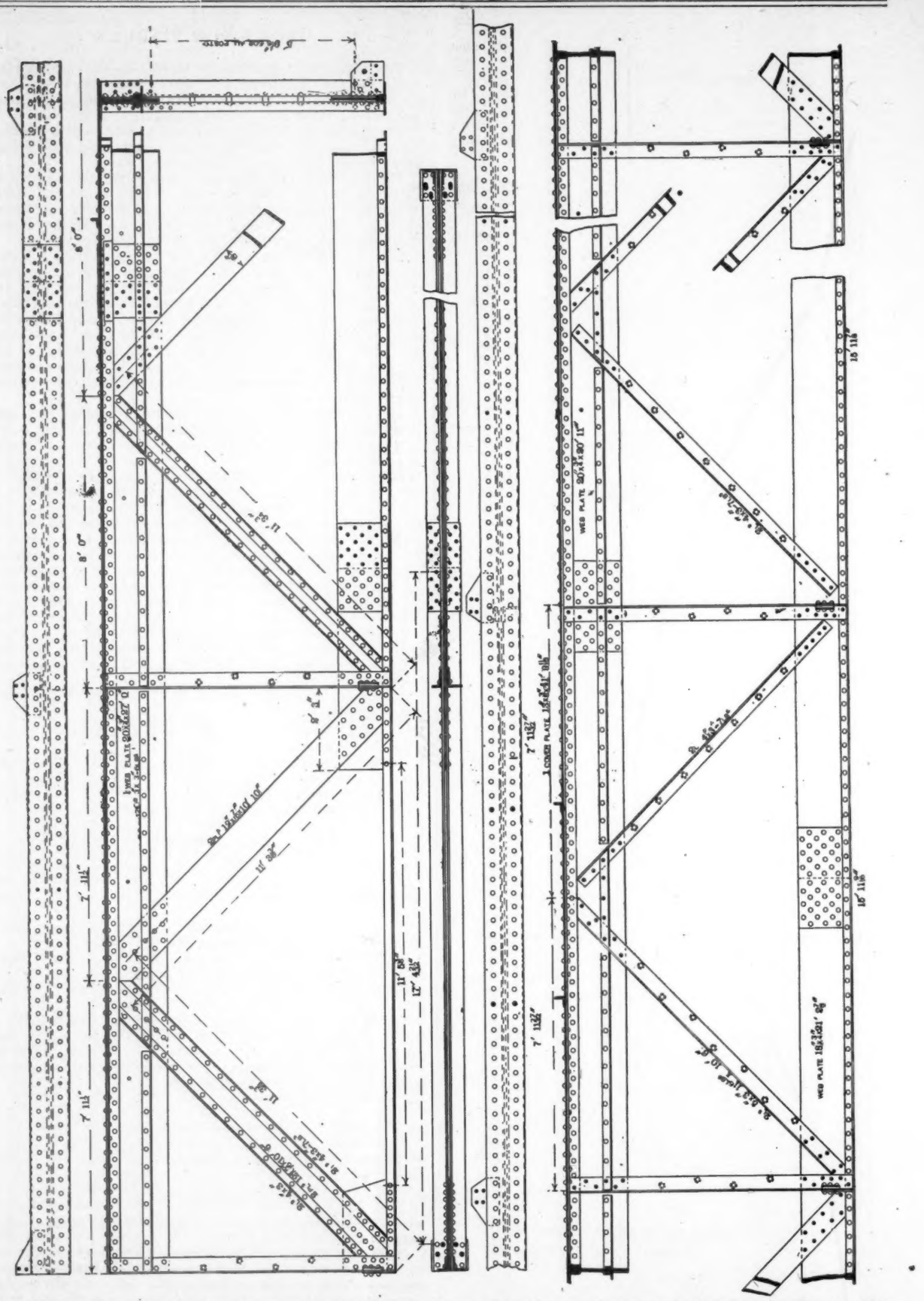
where P indicates the allowed compression per square inch of cross-section.

1, the length of compression members in inches.

R the least radius of gyration of the section, in inches.

Maximum fiber strains of white pine joists, 12,000 lbs. per square inch.

The structure was completed three months after approval of the plans, and even the extremely cold weather of last winter did not delay the erection, which began in December, 1892, at the Allegheny side, and reached a month later the Bellevue end.



No false work was used; all material was put in place by use of a traveling derrick with a projecting arm 115 ft., long enough to put a bent at the far side of the longest span.

The half-tone engraving shows the traveler in this position; it stands upon the double tower, ready to put the lower part of the tower at the far side of the 96 ft. span; the height of the projecting arm above the bottom of the valley is a little over 160 ft.

The total length of this traveler is 173 ft.; the height of its principal bent, 35 ft.; its width, 14 ft. The engine, 14 ft. long, stands as counter weight 44 ft. behind the saddle bent, and has an additional load of 40 cross-ties at each side of the

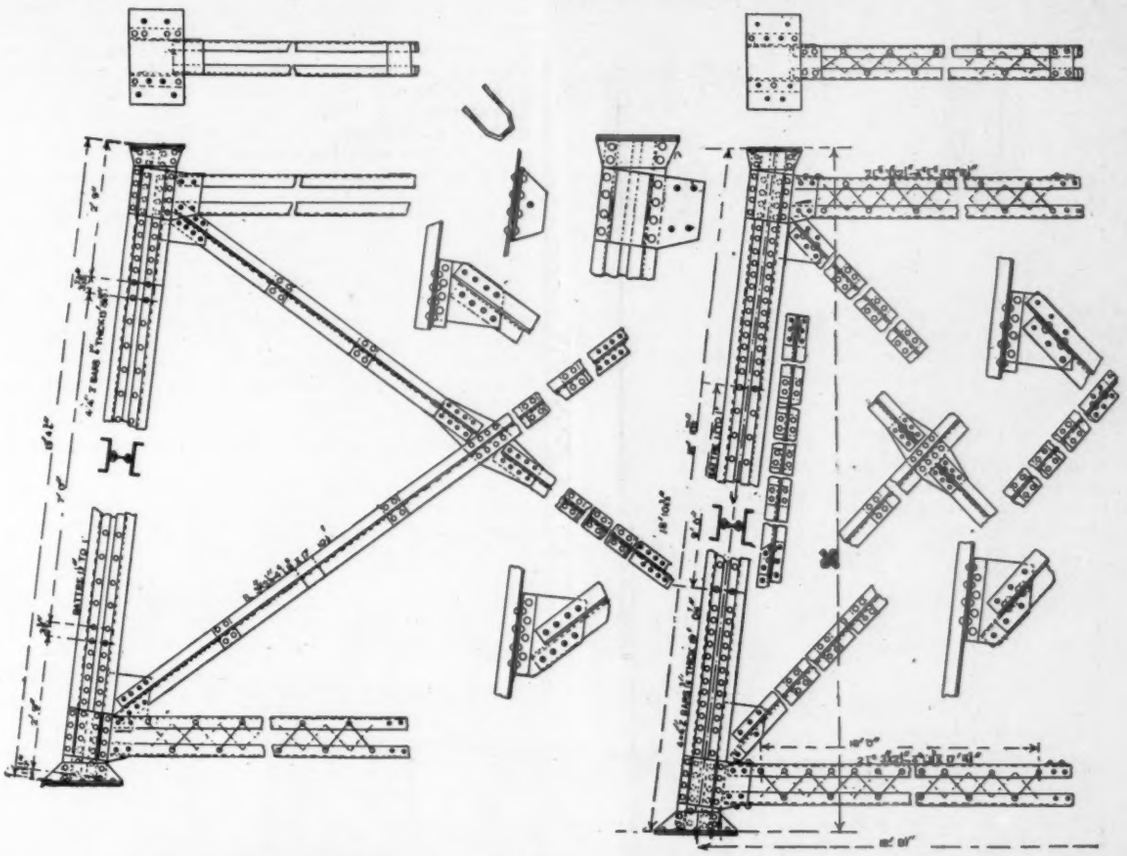
engine; the total weight of iron and timber in the traveler, the engine, the cross-ties and about 10,000 ft. of ropes, including blocks attached to the traveler, amounted to 57 tons.

For the purpose of getting a massive roadway floor, 6-in. arches of sharp burned hollow brick are to be built between the stringers; they are to be covered with concrete and with a top layer of asphaltum the height of the track rails. Temporarily a wooden floor has been laid.

The sidewalk will be planked.

The total amount of first-class masonry in abutments and piers is about 400 cub. yds., and of steel structure, 375 tons. The total cost will be $60,000.

The work was done by the Schultz Bridge & Iron Company of Pittsburg, Pa.



CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

I.—METHOD OF DETERMINING CARBON IN IRON AND STEEL.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(Copyright, 1891, by C. B. Dudley and F. N. Pease.)

(*Continued from page 252, Volume LXVII.*)

OPERATION.

Put 3 grams of fine borings of the iron or steel in a 16-oz. beaker or pint dissolving jar, and add 200 c.c. of an acid solution of the double chloride of copper and potassium which is at a temperature not above 100° F. Allow to dissolve, taking pains to agitate the liquid during solution. As soon as the separated copper has all disappeared, allow to stand a little while to settle if necessary, and then pour the supernatant liquid on an asbestos filter in a platinum boat, taking pains at the last to pour out all the liquid, and at the same time leave as much of the separated carbon in the beaker or dissolving jar as possible. Now add about 10 c.c. of dilute hydrochloric acid [sp. gr. 1.1] to the beaker or jar, and so manipulate that this acid shall touch all parts of the beaker or jar which has been in contact with the solvent liquid. Pour this acid on the filter, and wash the carbon out of the beaker or jar by means of a wash bottle containing the same strength acid. Continue the washing with the acid until all color has disappeared from the washings, and then wash with water until the washings no longer react for hydrochloric acid. After the washing is complete the filtrate should be poured into a large beaker and diluted with clean water, and acid added, if necessary, to hold the sub-chloride of copper in solution, until it is possible to see whether any carbon has escaped the filter. If any is found, of course the liquid must be passed through the filter again, or the material all thrown away, and a fresh start made. Dry the carbon at a temperature not above 212° F., and then place the boat with the dried material in it in the combustion furnace. While the drying is going on, weigh the absorption potash bulb and prolong, which have been previously prepared as described below, and place them in their proper position, in connection with the combustion train, which has likewise been previously prepared as described, and in which the preheating furnace has been lighted long enough, so that its porcelain tube is fairly red, for at least 5 or 6 in. of its length. Start the combustion by turning on enough burners at the front end of the combustion tube to embrace about 3 in. of it with flame, and at the same time see that the connection to the air gas holder is closed, and then open the connection between the oxygen gas holder and the combustion tube, and then adjust at the aspirator so as to allow about three bubbles a second to show in the absorption potash bulb. As soon as the combustion tube above the burners already lighted becomes perceptibly red, turn on enough more burners to embrace a couple of inches more of the tube, and allow this portion likewise to become perceptibly red. From this point turn on one or two burners at a time, allowing the tube above them to get red before turning on more, until enough have been turned on to heat the tube red a couple of inches toward the rear end from where the boat lays inside. Continue the combustion after the last burner is lighted, about 15 minutes for steel and not less than 30 minutes for pig or cast iron, taking care to keep the

flow of oxygen to the combustion tube sufficient to maintain a slight pressure in this tube, and at the same time not allow over about three bubbles per second to pass the absorption potash bulb. After the burning is completed, turn down the gas supply to the burners by means of a cock one-half, or turn out every other burner so as to allow the combustion tube to cool down slowly, and then shut off the oxygen supply and turn on the air supply for aspiration. Allow not less than a liter of air to pass through the absorption potash bulb, at a rate of not over three bubbles a second. While the aspiration is going on, diminish the gas supply to the burners by means

Fig. 1.

of the cock, or turn out additional ones as fast as the tube will stand it. When the aspiration is complete, detach the potash bulb and prolong from the furnace, close the ends with rubber caps, and place in the balance case. Allow to stand 15 minutes, and then weigh.

APPARATUS AND REAGENTS.

We prefer to use, in dissolving the iron or steel, a jar of thick, heavy glass, rather than a beaker. The jars we have found useful hold about a pint, and have a nose for pouring. One is shown in fig. 1.

about 40 in. long. The two horizontal parts at the top of the frame are perforated with $\frac{5}{8}$-in. holes 5 in. apart each way, which holes, without any bushing, serve as bearings for the hollow tubular shafts. The top of each shaft carries a wooden pulley 4 in. in diameter, which has a brass bushing and set screw by means of which it is fastened to the shaft. Brass washers between the pulleys and the top of the frame carry the weight of the revolving parts and diminish the friction. A little tallow and graphite on the rubbing surfaces is also valuable for the same purpose. We use an electric motor for power, and the glass stirring rods revolve about 400 revolutions per minute. By taking care to wash the stirring rods both before and after using they may be adjusted once for all and left in position. The beakers or dissolving jars are supported on wooden blocks of the proper height, which blocks are movable, so as to allow the beakers or dissolving jars to be put in position or removed from the same without difficulty. With this stirring apparatus and the amounts of material previously prescribed, complete solution takes place in from 7 to 45 minutes, depending on the size of the borings and the nature of the steel or iron.

As will be seen by the cut, fig. 1, the devices for filtration consist of a receptacle to receive the filtrate, which is connected at the outlet with the exhaust pump or suction, and at the inlet with the platinum boat. The platinum boat is about 3 in. long, $\frac{1}{4}$ in. wide at top, $\frac{7}{16}$ in. wide at bottom, and about $\frac{3}{8}$ in. high. It is fitted with a perforated false bottom, which leaves a clear space underneath it of about $\frac{1}{4}$ in. The boat is also fitted with a tubular opening at one end, which serves both as a means of connection to the inlet of the filtrate receptacle, and also as a passage-way from the boat for the filtrate. The boat rests on a clean glass plate, supported on a block, which glass plate serves to catch anything that may escape from the boat during filtrations, with a chance to recover the same if desired. This form of boat is as efficient as any we have ever seen, and seems to give less difficulty about keeping tight joints than those with perforated bottom. They may be obtained by special order from any dealer in chemical platinum.

The asbestos which we have found to give best results is the mineral known as "actinolite." We consider it essential to ignite the material as received after it has been picked up and

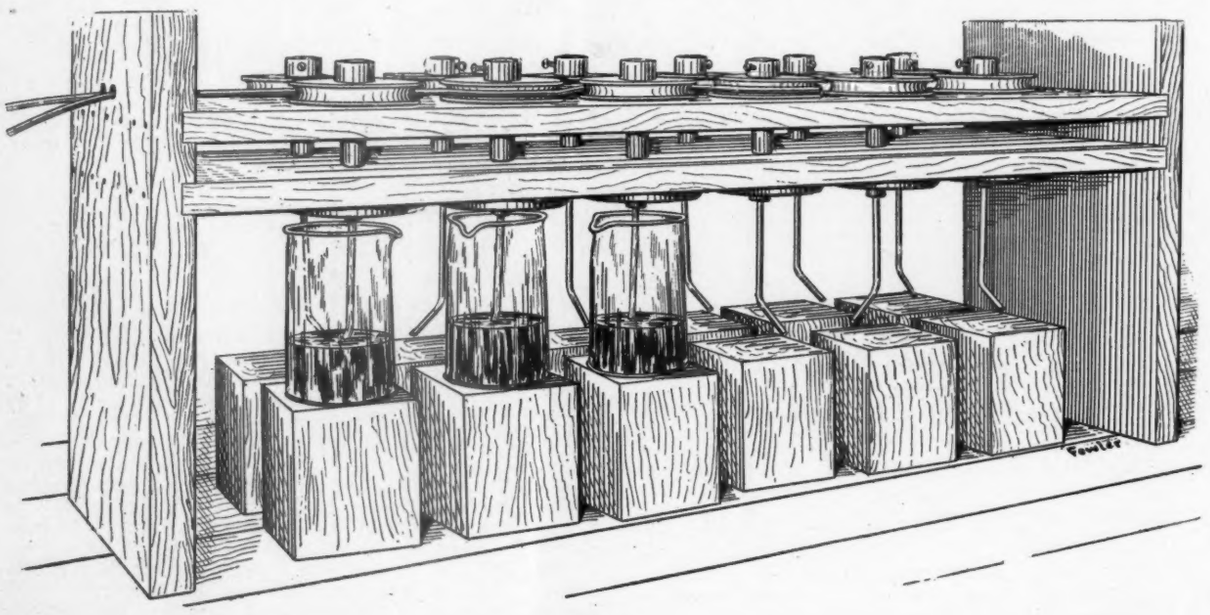


Fig. 2.

The agitating apparatus shown in fig. 2 consists, as will be seen, of a slight modification of the well-known stirring machine shown in the Chemical Analysis of Iron, by A. A. Blair, arranged to stir 12 beakers at once. The shaft carrying the stirring rod consists of a $\frac{5}{8}$-in. diameter brass tube, carrying at the bottom a disk which revolves with it. This disk, which is $4\frac{1}{2}$ in. in diameter and slightly turned up at the edges, serves very satisfactorily as a cover to the beakers in place of the perforated glass plate. The disk should revolve within about $\frac{1}{8}$ in. of the top of the beakers. The hole in the brass tube used as a shaft serves to receive the cork carrying the glass rod, which, as is observed, is bent at the lower end so that it will just nicely revolve in the beakers or dissolving jars. The frame of the apparatus is made of wood about $11\frac{1}{2}$ in. wide and

cut with shears into short lengths, either in a platinum dish over a Bunsen burner, or in the combustion tube itself, in a current of oxygen. After a quantity of the ignited material has been prepared it should be mixed with water in a beaker and kept under cover as stock supply. To prepare the filter in the boat everything is put in position just as for a filtration and the suction started. The asbestos and water mixture, which should be pretty well diluted, is first stirred up well, in order to make some of it float, and then poured on the boat its whole length, taking care to have the asbestos evenly distributed. The suction removes the water as fast as it is poured on, and shows where to pour next. A filter about $\frac{1}{16}$ in. thick seems to work very satisfactorily. It is usually not necessary to make a fresh filter after each combustion, espe-

cially if the copper is completely dissolved before filtration, and if proper care is taken to wash the carbon clean. Under these conditions the same filter may be used over and over again by simply scraping off a little of the top and freshening it up with a little of the asbestos and water mixture after each combustion.

The drying of the carbon on the filter may be done either in the well-known drying oven with hot water or in the drying oven with hot air. We use the latter with an automatic regulator on the gas supply to maintain constant temperature.

The combustion train is shown in fig. 3. Beginning at the left hand, first are two gas holders, one for oxygen gas and the other for air. These are simple copper gas holders, with movable weights for pressure. They are adjusted so that the pressure will just cause the gas to bubble through the purifying potash bulb next to the combustion furnace, but not cause it to pass through the bubble tube containing iron sulphate just to the right of the combustion furnace. The connection between these gas holders and what we call the preheating furnace is by means of rubber tubes and a glass Y-tube. These rubber tubes should, of course, be closed by a cock or clamp, so that gas can be taken from either without contamination from the other. The preheating furnace is, as will be observed, a simple 12-in. Fletcher furnace, fitted with a porcelain combustion tube ⅝ in. in diameter and 20 in. long, which contains granulated oxide of copper for about 8 or 10 in. of its length inside the furnace. A second combustion furnace would do equally well for a preheating furnace. The corks used with this and also with the combustion furnace are rubber; also rubber tubes are used for connections. The placing of the porcelain tube in the preheating furnace should be such that not less than 4 or 5 in. of its length projects toward the combustion furnace, so that this end may not become heated, with consequent danger of volatilizing hydrocarbons from the rubber cork; also, to prevent overheating of the porcelain tube, the gas holes in the gas tube of the preheating furnace are stopped up about 2½ in. each way from the ends. Next beyond the preheating furnace is an ordinary Geisler potash bulb, which may be called the purifying potash bulb, properly filled with caustic potash solution, to retain any carbon dioxide that may be in the oxygen or air used, or that may be formed in the preheating furnace from the combustion or any vapors containing carbon in these gases. The connection between this potash bulb and the porcelain tube in the preheating furnace should be so arranged that the glass tubes, which are embraced with the rubber tube at the joints, should have square ends, and should touch, so as to avoid exposure of the current of gas to the rubber tube as much as possible. This same remark applies to all other rubber tube connections. Next beyond the purifying potash bulb is the combustion furnace. The 14-in. Bunsen furnace gives excellent results. We use coal gas for fuel. The combustion tube is royal Berlin porcelain, glazed inside and outside, ⅝ in. internal diameter, and 24 in. long. The tube should be placed symmetrically in the furnace—that is, should project 5 in. at each end. It should be prepared for use by placing a small plug of asbestos or three or four disks of copper gauze, which are large enough to fit tightly at a point 6 in. from the right-hand end of the tube. Then put in granulated oxide of copper, followed by another asbestos plug or copper gauze disks for 4½ in. toward the left-hand end of the tube. Then make a roll of metallic silver foil, 2 in. long, rolled moderately closely, until it almost fills the bore of the tube, and place this next to the material already in the tube. This leaves abundant space in the tube for the boat, which should be pushed in so as to touch the silver roll. Next beyond the combustion tube is a bubble tube, not quite half full of acid ferrous sulphate solution, which serves to catch any free chlorine which may escape from the combustion tube, and next beyond this is a bubble tube, not quite half full of silver sulphate and water, which serves to catch any hydrochloric acid that may come out of the combustion tube, or from the ferrous sulphate bubble tube. The solubility of the silver sulphate being rather meager, it is desirable to add some of the solid salt to the bubble tube in order to prevent the necessity of too frequent charging of this tube. Next beyond the silver sulphate bubble tube is an ordinary chloride of calcium tube. In order to save space, we prefer the U form. Next is the absorption potash bulb. We prefer the Geisler form, and have them made so that when filled they, with the prolong, weigh from 50 to 60 grams. The ordinary size weighs from 80 to 90 grams. Next is the prolong, which is simply a small chloride of calcium tube filled with granulated chloride of calcium only. Next is another ordinary chloride of calcium tube to protect the prolong from moisture from the aspirator bottle. This bottle finishes the train. It is provided, as will be observed, with inlet at the top and side outlet at the bottom, which latter is also provided with glass tube of sufficient length to give the necessary suction, and a clamp on the rubber hose connection to regulate the flow.

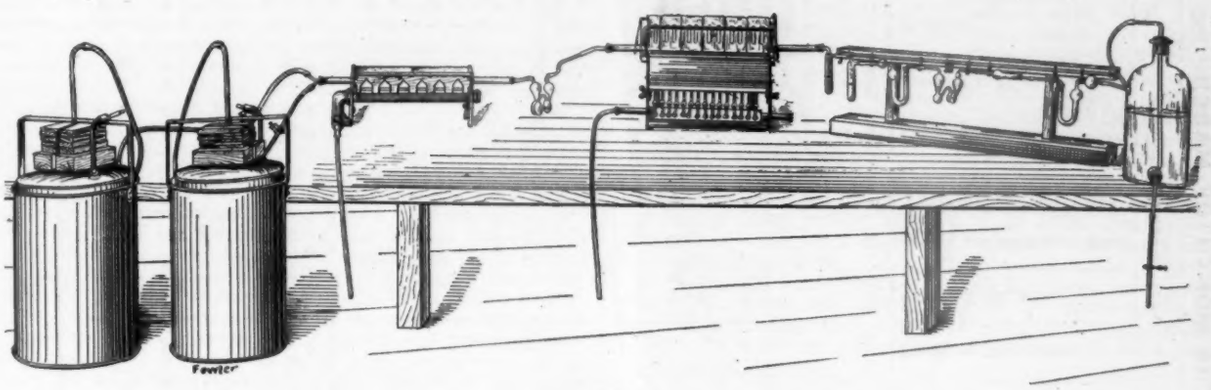


Fig. 3.

(TO BE CONTINUED.)

PHILLIPS'S FLYING MACHINE.

In our issue for June we presented illustrations of Phillips's flying machine, taken from *Engineering*, which give a very good idea of the general appearance of the machine. Since the publication of the above there has appeared in the London *Times* a description of the machine which, in some respects, is more complete than the one that we have already printed. We reproduce the more interesting details taken from the *Times*, referring our readers to our June issue for the illustrations of the machine.

The machine is built upon the principle of being sustained in its flight by means of induced currents acting upon slats or laths of wood arranged similarly to those of a Venetian blind, instead of the larger aeroplane to which designers of flying machines have usually had recourse. Not but that Mr. Phillips has used inclined planes, and used them of large size, too, but he has reduced their dimensions step by step, until the transverse sectional area of one of his present sustainers measures only 1½ in. in breadth by ⅛ in. in thickness at the front, tapering to nothing at the back. Broadly stated, the cross section of the slat is that of a knife-blade, with a thick edge at back and a thin one at front, and with the upper and under side of the slat curved, but both differently. The form, in fact, is such that when the machine is in motion the convex upper surface near the front or thick edge deflects the air upward, thus creating a partial vacuum on the upper surface of the slat. The under or concave surface of the slat is formed to a parabolic curve, which gradually puts the particles of air into motion downward, thus producing an excess of pressure on the under side of the slat. It thus follows that upon a forward motion being given to the machine, the horizontal air-pressure which is brought upon the slats becomes converted,

LOCOMOTIVE RETURNS FOR THE MONTH OF MARCH, 1893.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama, Great Southern	....	....	.....	.....	.....	.....	.. .	....	....	...	....	....	....	....	...	. ..	....	....	....	....	....	....	....	....	....
Alabama & Vicksburg	....	....	.....	.....	.....	.....	....	....	....	....	....	....	....	....	....	...	....	....	....	...	....	....	....	....	....
Atchison, Topeka & Santa Fé	884	....	.....	.....	1,906,471	2,264,546	3,790	....	....	....	....	....	88.45	....	....	5.94	7.14	0.27	1.58	6.66	0.18	21.77	....	....	1.55
Canadian Pacific	613	....	499,278	808,938	324,074	1,632,290	2,664	....	....	....	....	....	77.36	....	....	4.59	12.76	0.39	....	5.76	1.49	24.99	....	2.20	3.28
Chic., Burlington & Quincy	549	....	.....	.....	.....	1,847,001	....	4.90	17.71	....	....	....	91.49	....	....	5.68	6.64	0.25	0.34	6.49	0.09	19.49	....	....	1.44
Chic., Milwaukee & St. Paul	825	....	.....	.....	.....	2,599,545	3,041	....	....	....	....	....	71.25	....	....	4.12	7.89	0.28	...	6.86	....	19.15	....	....	2.00
Chic., Rock Island & Pacific	....	....	573,052	917,251	446,611	1,936,914	....	....	....	....	....	....	....	....	....	3.03	6.67	0.27	3.03	5.97	4.20	16.36	.. .	....	....
Chicago & Northwestern	888	....	709,964	1,470,673	680,993	2,861,630	3,222	....	....	....	....	....	93.62	....	....	4.09	8.40	0.37	....	6.40	0.90	20.16	....	....	1.77
Cincinnati Southern	....	....	.....	.....	.....	.....	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....	....	....	....	....
Cumberland & Penn.*	22	22	5,571	35,721	.....	41,292	1,876	....	....	....	....	....	91.18	....	...	7.27	4.96	0.39	....	...	1.87	14.49	....	....	....
Delaware, Lackawanna & W. Main L	....	190	....	.....	.....	669,340	3,522	....	....	.. .	....	....	88.77	....	....	3.37	6.88	0.39	....	5.89	....	16.53	....	....	...
Morris & Essex Division.. ...	159	..	172,340	162,144	101,861	436,345	2,745	....	....	....	....	....	70.92	....	....	4.07	10.99	0.41	....	6.22	....	21.69	....	....	3.07
Hannibal & St. Joseph	76	....	73,461	176,092	41,271	290,770	3,983	5.22	16.14	....	....	....	86.91	16.36	6.70	5.05	6.29	0.11	0.37	6.66	0.08	18.51	....	....	1.40
Kansas City, F. S. & Memphis	150	....	101,399	280,384	119,193	500,976	3,339	....	....	....	....	....	69.17	....	....	3.92	5.83	0.28	....	7.49	0.37	17.89	....	....	1.65
Kan. City, Mem. & Birm	42	37	36,557	61,661	14,163	112,381	3,037	....	....	....	....	....	98.89	....	...	4.18	3.75	0.22	0.33	6.95	....	15.43	....	....	1.05
Kan. City, St. Jo. & Council Bluffs	38	34	59,644	47,143	41,374	148,161	4,064	5.05	21.12	....	....	. ..	67.66	14.25	4.69	4.43	6.36	0.15	0.49	5.86	0 03	17.32	....	....	1.98
Lake Shore & Mich. Southern	599	....	457,514	966,185	561,117	1,984,816	3,525	....	....	....	....	....	71.41	....	....	3.32	5.63	....	0.19	6.95	0.16	16.25	....	....	1.57
Louisville & Nashville	....	348	436,852	823,311	381,927	1,642,090	3,627	5.03	16.44	64.50	115.54	49.04	84.72	12.91	6.78	4.42	6.69	0.26	1.41	6.08	0.59	19.45	3.29	1.46	1.58
Manhattan Elevated	....	297	786,558	.....	62,236	848,794	2,857	....	....	...	....	....	48.78	....	....	2.50	9.80	0.20	....	8.90	....	21.40	....	....	4.01
Mexican Central	148	114	.....	.....	.....	400,890	3,516	...	....	....	....	....	71.76	....	....	5.17	14.54	0.48	0.18	5.18	0.81	26.36	....	....	4.80
Mil., L. S. & Western	112	....	79,298	139,176	80,082	298,556	2,665	....	.. .	....	....	....	80.97	....	....	3.13	11.27	0.21	....	6.31	0.96	21.88	....	....	2.80
Minn., St. Paul & Sault Ste. Marie	...	....	64,735	150,514	38,117	253,366	....	4.34	16.75	....	....	....	92.54	....	....	5.14	15.66	0.26	...	6.74	....	27.80	....	2.50	3.38
Missouri Pacific	339	303	1,453,927	9,382,962	.....	1,117,942	3,656	4.35	16.16	....	....	...	88.18	....	....	6.32	6.19	0.31	1.38	6.47	1.56	22.13	4.41	1.68	1.37
Mobile & Ohio	107	89	74,903	149,640	62,318	286,861	3,223	...	....	....	....	....	67.61	....	....	2.98	4.80	0.22	0.62	5.75	0.98	15.35	....	....	1.43
N. O. and Northeastern	....	....	.....	.....	.....	.....	....	....	....	....	....	....	....	....	....	....	...	....	....	....	....	....	....	....	....
N. Y., Lake Erie & Western	....	611	463,388	957,410	286,257	1,707,055	2,619	4.50	21.40	83.60	141.80	85.65	....	20.60	6.60	5.38	8.55	0.38	2.00	7.41	1.15	24.87	....	....	1.46
N. Y., Pennsylvania & Ohio	257	...	136,545	475,885	153,088	765,518	2,978	5.50	17.70	68.90	122.80	70.20	....	12.50	6.90	4.43	5.72	0.30	2.78	6.84	1.01	21.08	....	. ..	1.12
Norfolk & Western, Gen. East. Div.‡	....	....	116,620	304,339	58,079	479,040	2,869	4.70	20.50	51.70	124.40	....	....	11.00	6.10	5.50	3.80	0.07	....	....	....	10.00	....	....	....
General Western Division‡	....	....	108,600	316,486	44,890	469,976	2,889	5.46	16.82	73.00	141.00	....	125.00	....	....	7.59	4.52	0.63	....	....	....	12.74	....	....	....
Ohio and Mississippi	....	...	.....	....	.....	.....	....	....	....	....	....	....	....	....	....	....	....	....	....	...	...	....	....	....	....
Old Colony	....	242	345,924	143,753	241,075	630,742	2,606	...	....	....	....	....	65.19	...	....	3.32	12.22	0.62	....	6.73	0.81	23.70	....	...	3.75
Philadelphia & Reading	....	....	480,098	370,583	1,158,702	2,009,383	.. .	....	....	....	....	....	89.96	....	. ..	4.85	5.04	0.30	....	5.76	0.40	16.35	....	....	....
Southern Pacific, Pacific System	..	719	.....	.....	.....	1,708,627	2,376	...	....	....	...	....	68.74	....	....	6.27	17.79	0.21	2.24	7.31	1.22	35.04	....	.. .	5.28
Union Pacific	992	....	709,270	1,274,825	489,830	2,473,925	2,492	5.59	16.38	83.12	138.98	....	100.60	14.93	8.47	7.43	10.35	0.43	0.92	8.15	1.22	28.50	4.55	2.24	2.05
Vicksburg, S. & P	....	...	.....	... .	.....	.....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Wabash	425	369	406,616	713,647	319,226	1,439,389	3,900	4.97	17.12	73.55	113.83	62.61	91.11	14.78	6.65	3.38	5.17	0.29	....	6.34	0.84	16.02	2.91	1.05	1.16
Wisconsin Central	153	120	127,625	263,570	73,337	464,532	3,871	....	....	....	....	....	94.65	....	....	2.94	11.34	0.27	....	7.14	....	21.69	....	....	2.37

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

‡ Wages of engineers and firemen not included in cost.

by reason of the form of the slats, into an upward vertical pressure which acts as a lifting power and raises the machine into the air.

There are 50 of these sustainers or slats, each 1½ in. wide and 22 ft. long. They are fitted 2 in. apart, and with their edges horizontal, in a frame 22 ft. wide and 9 ft. 6 in. high. These sustainers have a combined area of lifting surface of 136 sq. ft., and they are carried in their frame upon a carriage resembling a canoe 25 ft. long and 1 ft. 6 in. wide at the rear, but tapering to a point at the front. The frame of slats is fixed transversely to the length of the carriage, and in outline the whole resembles a small boat fitted with a large sail. As this machine is not yet allowed to soar away into space, but is earth-bound, it is mounted on a pair of 12-in. wheels at the rear and a guide wheel of the same diameter in front. Upon the carriage and near the sustainers, which are at the rear end, are placed the engine and boiler and the air-propeller. The engine is compound, having cylinders 1¾ in. and 3¾ in. in diameter respectively, with a 6-in. stroke, and fitted with ordinary slide valves. The boiler is a cylindrical vessel of phosphor bronze 12 in. in diameter and 16 in. long. It has 12 sq. ft. of heating surface, made up of Field tubes of ¾ in. outside diameter and 14 in. long. The fire-grate area is 70 sq. in., and the fuel used is Welsh coal, the working pressure being 180 lbs. per sq. in. The propeller is two bladed, 6 ft. in diameter, and of 8 ft. pitch, and has 4 sq. ft. of blade surface. It is driven at the rate of about 400 revolutions per minute. The weights of the various parts of the machine are: Carriage and wheels, 60 lbs.; machinery, with water in boiler and fire on grate, 200 lbs.; sustainers, 70 lbs.; total weight of machine in working order, 330 lbs.

In order to test this machine a circular wood track 628 ft. in circumference has been laid down in the grounds of Messrs. Cogswell & Harrison's gun factory at Harrow. It was tethered by wires to a central post, the wheels being arranged so as to run in a circular path. Besides its own weight the machine carried 56 lbs. of shot and 16 lbs. of iron. The field in which the track is laid has a slight incline, and at the time of the trial a fresh wind was blowing. A number of runs were made, the result of which was, as regards horizontal motion, a speed of 28 miles an hour when the machine had got up speed and was well on its way. As regards vertical motion, with speed well on and facing the wind the rear end of the machine was lifted a *maximum* of about 3 ft. from the track, the lifting, to a greater or less height, continuing over about two-thirds of the course. The machine was then tethered from behind and the machinery started, when it was found to exert a dead pull of 75 lbs. As previously stated, the machine was held captive, there being insufficient room to experiment with it free, which also for other reasons is at present undesirable. Sufficient, however, has been done to demonstrate that it possesses a tendency to ascend, and, this having been ascertained, it remains for the principle to be applied to a machine which shall be capable of sustained aerial flight. And, to be a success, not only must it be capable of sustained flight, but it must be capable of correctly poising itself in the air during flight and during a gently inclined descent, should the propelling power by any accident become inoperative. This, it is claimed, the machine in question will do. Theoretically it should.

A late number of the *English Mechanic* reports that Mr. Phillips's flying machine is said to have soared "without touching," the speed being 40 miles an hour.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.*

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in May, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN APRIL.

Since our list of accidents which occurred in April was published, we have received information of the following which occurred in that month:

Waco, Tex., April 22.—C. M. Hilbert, fireman, and Ed Harding, engineer of Cotton Belt freights, were crushed in a railroad accident at this place. Hilbert is dead, and Harding not expected to live.

Port Byron, N. Y., April 23.—Edward Dougherty, of East Syracuse, a fireman on the Central Railroad, met a horrible death early yesterday morning. While his freight train stopped in the yard he went under the engine to take out the cinders. Unaware of his position, the engineer started up. Dougherty's body was frightfully mutilated. The train proceeded two miles before the accident was discovered. A following train completed the work of mutilation.

Somerset, Pa., April 25.—Five persons were killed, two fatally injured, and a number of others hurt in a runaway train accident on the Bare Rocks Railroad. The train, loaded with stone and carrying about 20 workmen besides the crew of the train and several passengers, while coming down the heavy grade became unmanageable, and crashed into a number of loaded cars standing on the track. The locomotive was completely demolished, and the cars piled on top of one another in a huge mass.

Of the injured, Neff, the engineer, is the most seriously hurt, being badly scalded and one of his arms broken. He will recover. His son was so badly scalded that he died a few hours after the accident.

Meyersdale, Pa., April 30.—Thomas Muldoon, fireman on engine 561, which was hauling one of the circus trains to Pittsburgh, Sunday, was severely injured at Garrett, while standing on a box car and coming in contact with the top of the bridge at that place.

ACCIDENTS IN MAY.

Sarnia, Ont., May 3.—Harry Ryan, an engineer on the Chicago & Grand Trunk, met with a peculiar and painful accident. He was running his engine against a strong head-wind between Lansing and Battle Creek. As the fireman opened the furnace doors the flames shot out. As the engineer's clothing was covered with oil it readily took fire, and Mr. Ryan was severely burned about the legs, body, arms, and hands before the flames could be extinguished. The wind was blowing a gale at the time.

New Brunswick, N. J., May 3.—Edward Wilson, a fireman in the employ of the Pennsylvania Railroad, while making some repairs to his engine at East New Brunswick on Wednesday night was struck by a passing train and had his skull fractured. His recovery is doubted.

Niagara Falls, May 6.—Two box cars loaded with sand on the Niagara Falls Park & River Railway broke loose on the Queenston Mountain Saturday evening and started down the swift incline. Patrick O'Neill, the fireman on the dummy engine used on the road, was on the cars. He attempted to stop the heavy cars by putting on the brakes. They failed to make any impression, and the man jumped when they were running at a 50-mile clip. He suffered severe bruises and a broken leg.

Port Huron, Mich., May 6.—George W. Rutherford, a Chicago & Grand Trunk engineer, was caught between two engines this forenoon and quite severely injured.

Lafayette, Ind., May 7.—On approaching this place on a descending grade, it is said that the air-brakes would not work, and the engineer called for brakes and whistled the danger signal, but the speed could not be checked, and the train shot down the grade and across the Wabash River at the rate of about 75 miles an hour.

There is a short curve where the track enters the Union depot, and at this point the train left the track, tearing through the depot, knocking down the iron sheds and smashing the express, two mail cars, and a combination car to splinters, and piling the rest of the train on top of them, the engine being buried out of sight.

Michael Walsh, engineer, and Sterling McInnis, fireman, and eight other persons were killed and 10 were injured. Engineer Walsh was seen by the fireman of a Big Four freight train that was lying on the west track near the depot as the

* In our report of accidents that occurred in February, which was published in April, was an account of the explosion of engine No. 103 of the Baltimore & Ohio Railroad at Norwood. An officer of that road requests us to say that they had no engine No. 103 at that time, there is no Norwood on their line, and they have not had an explosion for the last four years, and do not expect to have any. Our reports of the accidents which we publish are taken chiefly from the daily papers, and it is of course impossible for us to verify their correctness. We regret though that we did injustice to the Baltimore & Ohio road or any of its officers.

fated express dashed by. He was at the throttle, apparently reversing the engine. When the engine left the track it turned on its side, and Walsh jumped. He was caught by the front car and jammed into the works of the engine, which were still running. His body, which was mangled beyond recognition, was not rescued until late this afternoon. The body of McInnis was also terribly mutilated.

Not one of the passengers killed was aboard the train. They were waiting in the depot to board it, and, hearing the approach of the train, which could not be seen, stepped out of the waiting-room under the sheds and were caught, as was also Meyers, the hackman. John Lennon was sitting in his mail wagon, from which he could not escape, and was killed in his seat.

Columbia, Pa., May 7.—Charles Harner, an extra fireman on the Pennsylvania Railroad, when near Downingtown was sent out to flag approaching trains. When several hundred yards from his train he seated himself on the ties close to the rails, where he soon fell asleep. The noise of an approaching train failed to awaken him, and every attempt to hold the heavy train proved useless. In a few moments the engine was upon him, striking his back, hurling him a considerable distance. Harner was found lying along the track in an unconscious condition and bleeding profusely. He is not nearly as seriously injured as first thought.

Akron, O., May 8.—George Kiehl, a fireman on the Creston local on the Erie Railroad, was seriously injured and narrowly escaped death at Creston yesterday. The train was on the siding at Kent awaiting No. 4, the through express. As it dashed past Kiehl put himself partially out of the window, and was struck by the baggage car. He was almost drawn from the cab by the blow, but kept his place. His wrist was broken and he was otherwise injured.

Little Falls, Minn., May 11.—Thomas McGinnis, who runs the switch engine in the N. P. Railway yards, was run over by train No. 1 at Staples, and had both his legs crushed off. He was taken to a hospital at Brainerd, and was reported to be dying this morning.

Steubenville, O., May 12.—Frank Burns, a fireman on the Panhandle Railroad, was injured by his head coming in contact with some object while he was looking out of the cab window. It is said he would not recover.

Cairo, Ill., May 13.—The south-bound passenger train on the St. Louis & Southwestern Road was wrecked at 5 o'clock this evening 7 miles below Bird's Point, Mo. Engineer King, of Mt. Carmel, Ill , and Fireman Smith were instantly killed.

Reading, Pa., May 13.—Two persons were killed and several severely injured by the explosion of a locomotive on the Lebanon Valley branch of the Philadelphia & Reading Railroad at Lebanon this morning The killed are Levi Yocum, engineer, of this city, and John Yocum, of Lebanon, aged 14, a nephew of the engineer, who had got on the engine to see his uncle. George Sallada, conductor, of Reading, was fatally injured ; Grant Seiler, a boy, of Lebanon, who was riding on the engine, seriously hurt ; William Ansbach, crossing watchman, fatally injured. The latter's daughter Annie, aged 16, who had just brought her father's dinner, was also seriously and perhaps fatally injured. Isaac Beard, of this city, front brakeman, was severely injured. Several persons living half a block from the scene of the explosion were slightly injured. Their names have not been learned. The locomotive is a complete wreck. Several of the victims were blown half a square away.

Oakland, Cal., May 13.—In a collision at this place Engineer Kimball had his ankle badly injured.

Mascoutah, Ill., May 15.—A west-bound train on the Louisville & St. Louis Air Line Road ran into an open switch near West Belleville last night.

Fireman John Menker and a brakeman were killed outright. Engineer Mahaffey sustained injuries that will likely prove fatal. The engineer saw the open switch too late. He reversed his engine and jumped, but was caught under a carload of ties.

Anaconda, Mont., May 15.—Engineer George Eldredge and Brakeman James Morrison were severely injured in a wreck by which Fireman Stroub lost his life.

Lynchburg, Va., May 16.—It is reported that a head-on collision occurred at Six Mile Bridge last night on the Norfolk & Western Railroad, in which both engineers and firemen were badly injured.

Meadville, May 16.—Train No. 3 on the New York, Pennsylvania & Ohio Railroad ran into a landslide near Venango, 8 miles north of Meadville. Engineer Orrin Luke was fatally injured and the passengers badly shaken up, but none seriously hurt.

Hamburg, Pa., May 17.—A freight wreck occurred on the Reading Railroad at the sharp curve a short distance south of this station. A north-bound freight train ran into the rear end of a coal train, piling up a number of cars and wrecking them badly. Engineer Frank Fry, of Philadelphia, of the freight train, was injured.

Bradford, Pa., May 17.—While coming down a steep grade at Big Shanty a Buffalo, Rochester & Pittsburg coal train dashed into a work train standing on a cut. Falicia, foreman of the construction gang, was killed and two other Italians injured, one of them fatally. Engineer McClary of the work train jumped and sustained a broken shoulder.

Bradford, Pa., May 17.—A. P. Rogers, an engineer who had secured a position with the Buffalo, Rochester & Pittsburgh Company, was taking a trip with Engineer Breese to learn the road. When coming down the grade this side of East Concord the long train was hard to control, and as the air-brakes did not work well, they were not used. The engine had to hold the cars in check. While this was being done the pin in the coupling attaching the train to the locomotive jumped out, and the detached engine bounded ahead of the train. The locomotive was soon slacked up, and when the cars behind struck against it, Mr. Rogers was hurled out of the engine cab and down an embankment. He struck on one of the timbers at the approach to the Cattaraugus viaduct, and was badly hurt about the head and body. A deep gash was cut under his jaw, and he was severely stunned.

Canton, O., May 19.—As Engineer Al Worthen, Fireman Frank Turner, and Conductor Ed Smith were coming from Navarre on the W. & L. E. Railroad with engine No. 37 and a caboose, at a point about one mile south of the station, near the Runser Farm, the train was passing over a bridge at that point on a side track, when suddenly the bridge, track, abutments, engine, caboose, crew and all passed down into the river. None were hurt except the engineer, whose injury is of a trifling nature, he having only sprained his back, but all were given a cooling bath and had to swim out. The wreck was caused by the water weakening the abutments.

Albany, May 19.—A collision between a gravel train and a west-bound fast freight occurred at Little Falls this forenoon on the New York Central Road. The gravel engine was derailed and 12 cars of the fast freight demolished. Tracks 1, 2 and 3 were blocked. Engineer O'Hara of the gravel train was seriously hurt.

New York, May 20.—Henry Hammond, aged 23, an engineer, residing at 157 East Thirty-ninth Street, last evening, in attempting to jump on board a moving train at Sherman Park, was thrown under the wheels. Both legs were cut off below the knees. He was taken to the Grand Central station, and from there to Bellevue Hospital. He will die.

Lancaster, Pa., May 20.—A broken truck of a freight car wrecked several cars on the Pennsylvania Railroad, near Thorndale. An east-bound train ran into them, and 20 cars in all were wrecked. Engineer C. W. Mann and Fireman John McCann, of Harrisburg, were badly injured, the former dying this afternoon. The fireman is in a serious condition.

Thorndale, Pa., May 20.—While pulling a freight train out of a siding another train crashed into its side on the Pennsylvania Railroad, wrecking the engine and 24 cars and terribly scalding Mann, the engineer, and his fireman. As quickly as possible they were extricated from the wrecked engine and taken to the Presbyterian Hospital in Harrisburg, where at 10.30 yesterday morning Mann died.

Wilkesbarre, Pa., May 22.—George Dotter, a fireman on engine 650, met with an accident at Pittston Junction that will in all probability prove fatal. He was hanging out the cab window when his engine crashed into a freight car that was not pushed in far enough off the main line. He was thrown from the cab to the track.

Waycross, Ga., May 23.—As the passenger train on the Waycross Air Line Railroad reached Kettle Creek trestle, the engine jumped down the embankment followed by the train of loaded cars, and the train was almost a total wreck. The engineer and fireman escaped with a few bruises.

Fort Madison, Iowa, May 24.—A wreck occurred on the Atchison, Topeka & Santa Fé Road, about 20 miles west of New Boston, at 12.30 P.M., when a freight engine crashed into the California express, west-bound, badly crippling both engines. Fireman Sleptuns, of the passenger, was scalded to death by escaping steam, and the engineer, Andrew Smith, dangerously hurt.

Austin, Tex., May 28.—In a collision on the suburban railroad to the dam near this city two persons were killed and 10 were injured. The dead are : Charles Link, fireman ; Francisco Salio, passenger. All the injured were terribly cut. The collision was caused by the incoming train neglecting to obey orders to take a side-track to allow the other train to pass.

Shelbyville, Ind., May 28.—A passenger train was derailed

by a blind horse, which wandered on the track and was struck by the engine.

As the engine went over, Fireman Williams was thrown from the cab over a barbed-wire fence at least 15 ft. away. Engineer Plant was buried in the wrecked cab. He was not pinned down, but was doubled up in a small space, with one hand on the throttle and the other on the reverse lever. He was literally cooked by the steam, great strips of flesh peeling from him.

As soon as he could get on his feet Fireman Williams ran to the locomotive and assisted in taking out his engineer. The unfortunate man was conscious, and said: "Oh, what will my wife do when she hears this—it will kill her."

He died soon after. Fireman Williams was hurt about the back, but his injuries are not thought to be fatal.

Quanah, Tex., May 30.—Passenger train No. 2 was derailed 6 miles north of Quanah by striking a cow on the track, killing the fireman outright and badly injuring Engineer Samuels.

Avoca, N. Y., May 30.—Engineer William Masters, of Erie freight train No. 134, was at the station, and after receiving orders, directed his fireman to pull out. He then boarded the rear end of the train, and while walking over the cars slipped and fell to the ground. He lay there stunned until found a little later by the crew of an extra west-bound freight. He was badly shaken up, but it is thought will recover.

Canton, O., May 30.—As engine No. 20 of the Valley Railroad was pulling an excursion train, and when near East Akron, the right side-rod broke near the middle, badly wrecking the cab and tearing the running board brackets off, thereby allowing steam and water to escape. The engineer was pretty badly shaken up, but not seriously injured. The fireman reached over and applied the airbrake with his foot. The rod was of the strap pattern.

Lebanon, N. H., May 31.—The Montreal daily express left the rails just below Roxbury, Vt. A misplaced switch was the cause, and the locomotive went down an embankment, carrying with it the baggage and mail cars, and the forward end of the first passenger coach. The fireman, seeing his immediate danger, jumped, landing in the mud, while the brave engineer, O. R. Kirk, of St. Albans, held his post. The escaping steam for a few moments made a search impossible, but later Engineer Kirk was extricated from his perilous position. Mr. Kirk was pinned down in the cab against the firebox by the reverse lever, and could not be liberated for over three hours. His legs were broken and he was frightfully burned, but he stood the terrible ordeal without a murmur, and died about 8 o'clock this forenoon.

Parkersburg, W. Va., May 31.—A head-end collision between an engine and a freight train occurred near Little Hocking on the Baltimore & Ohio Southwestern. Engineer Ball jumped and was thrown into a ditch and had a leg broken. His fireman was pinned in the cab, but escaped with only slight injuries. Engineer Shafer also jumped before the trains came together and escaped without injury, but his fireman, Mike O'Brien, was caught between the rear of the boiler and the top of the cab and was nearly cooked by the escaping steam, and is fatally hurt.

Chattanooga, May 31.—There was a head-end collision between freight trains on the Cincinnati Southern near Rathburn, Tenn., owing to a mistake in orders. Fireman McClellan was seriously injured and both engines and 10 cars totally wrecked.

Our report for May, it will be seen, includes 35 accidents, in which 10 engineers and 10 firemen were killed, and 17 engineers and 11 firemen were injured. The causes of the accidents may be classed as follows:

Boiler explosions	1
Broken coupling-rod	1
Derailments	6
Collisions	8
Falling from train	2
Failure of bridge	1
"Wrecked"	3
Runaway trains	3
Struck by train	3
Struck by other objects	1
Gas explosion from furnace door	1
Run over	2
Open switch	1
Landslide	1
Broken truck	1
	35

PROCEEDINGS OF SOCIETIES.

Boston Society of Civil Engineers.—At the meeting held on May 17 Mr. Dexter Brackett gave an account of the freezing of the main supplying water to Long Island, in Boston Harbor. About 1,200 ft. of 6-in. pipe laid with the Ward flexible joint across a channel between Moon and Long Islands was frozen during the past winter. The pipe, where frozen, was constantly covered with from 15 to 25 ft. of water, and the freezing was due to the fact that the salt water of the harbor, by which the 6-in. pipe was surrounded, was cooled to the temperature of 28° F. Many of the pipes, instead of being burst by the freezing water, were separated at the joints—that is, the spigot ends of the pipes were drawn entirely out of the bells into which they had been leaded.

Engineers' Club of Philadelphia.—At the meeting of the Club, held on June 3, a number of technical questions were brought up for discussion. Among them was that of the Load for Ball Bearings. Mr. Wilfred Lewis opened the discussion, and explained that the question was intended to cover roller bearings as well as ball bearings, and that, in view of the large and increasing demand for these bearings, it was remarkable how little definite information could be obtained concerning them.

Some time ago he wrote to a prominent manufacturer of ball bearings for such data as could be given in regard to the carrying capacity of hardened steel balls between plates of the same material, and in reply he was informed that almost nothing was positively known. Some crude experiments had been made upon $\frac{1}{2}$-in. balls, which showed them to have an ultimate strength of 2,000 lbs., and a safe working limit of 400 lbs.; but for car journals, in which the motion was continuous and rapid, 200 lbs. per ball was recommended as preferable. Whether a $\frac{1}{4}$-in. ball would carry twice as much or four times as much as a $\frac{1}{8}$-in. ball could not be stated, but the impression seemed to be that, over a given extent of surface, more load could be carried on small balls than on large ones. The effect of hardening was believed to increase tenfold the carrying capacity of a ball bearing.

In regard to roller bearings, but one formula is known to be in common use. This makes the load carried by any given roll proportional to the square root of its diameter, and the general adoption of this formula may be credited to the authority of the late C. Shaler Smith, while the investigation upon which it is based is said to be due to Professor Grashof.

The Engineering Association of the South.—At the regular meeting of the Engineering Association of the South, Nashville, Tenn., June 8, 1893, a paper on the Pecos Viaduct was presented by Mr. J. Kruttschnitt. In the original construction of the Galveston, Harrisburg & San Antonio Railroad (Southern Pacific), the deep cañon of the Pecos River presented such difficulties that, to avoid it, a considerable *détour* was made and the line built with heavy curvature and grades, yet at great expense; besides, operating expenses were large, and the unstable nature of the rock made necessary constant patrol of the track and reduction of train speed. These difficulties led to the location of a cut-off, crossing the Pecos River on the viaduct described.

The two lines are thus compared:

	Operated Line.	Cut-off.
Actual length in miles	24.5	13 3
Comparative length reduced to level tangents	33 77	17.9
Number of feet wooden trestles	3,600	600
" " iron bridging	2,730	2,180
Weight of iron bridging in pounds	3,893,000	3,640,000
Number of degrees of curvature	2,926.6	991.7
Maximum degree of curvature	10	5
" grade in feet per mile	52.8	52.8
Feet rise and fall	902.27	524.38

The masonry piers and footings are of tough limestone laid in Portland cement mortar, and were built between March and November, 1891, 3,270 cubic yards costing $70,000.

For comparison, the lengths, heights and weights of the six highest viaducts in the world are given:

Name.	Length between abutments.	Base of rail to water level.	Weight in pounds.	Weight per sq. ft. vertical projection.	Live load per lineal foot.
Garabit	1,813.00	401.80	7,040,000	22.74	3,220 lbs.
Loa	800.00	336.00	2,497,600	20.00	2,800 "
Pecos	2,180.50	320.80	3,640,000	13.32	5,000 and 30,000 concentrated.
Malleco	1,139.80	312.90	3,148,886	15.50	2,750 lbs.
Kinzua	2,044.00	301.10	3,500,000	9.10	....
Evaux	812.20	299.50	2,682,998	19.17	....

This table shows that the Pecos ranks one of the highest viaducts in the world, also that it leads in live load specifications and lightness. One of the most remarkable features in the work was the traveler used in erecting, with its overhang,

perhaps unequaled, of 124.5 ft., which was secured by a 57-ft. wheel base, the traveler being counterbalanced and clamped to the completed parts of the structure. The iron was brought out on push cars on the permanent track, taken by the crab on the traveler, lowered and held in position till the connections were made. The heaviest pieces weighed 11 tons. After erecting the east half of the structure, the traveler was taken to pieces and shipped by the operated line to the west half, a lighter traveler meanwhile raising the short towers at the west end. In erecting the east half 41,000 lbs. iron was averaged per day net time, and 62,000 lbs. in the west half. The average number of men employed in erecting was 67 ; and 87 working days were consumed from beginning erection to connecting the suspended span. The superstructure was built by the Phœnix Bridge Company. The floor timbers are covered by galvanized iron for fire protection. The total cost was $250,000.

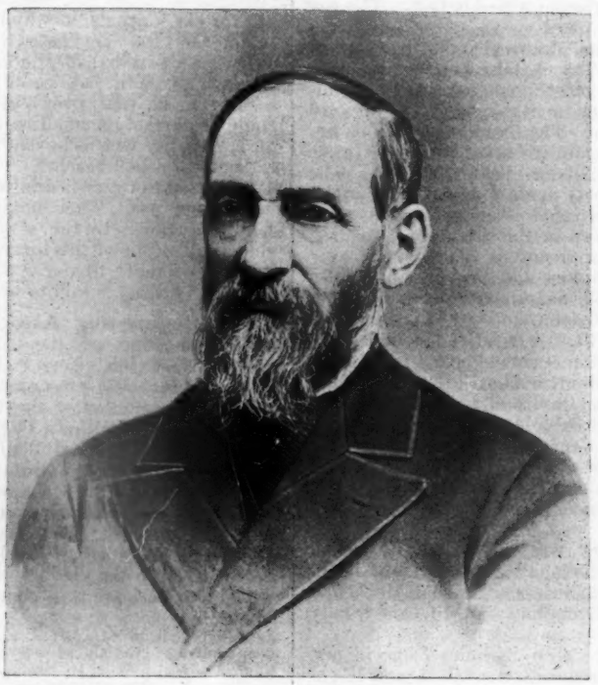
The paper was fully illustrated by drawings and photographs.

The next meeting of the Association will be held in Nashville, July 13, 1893.

OBITUARIES.

Walter McQueen.

THE death of Walter McQueen, which occurred at his home in Schenectady, N. Y., on June 16, has removed the last of the early generation of locomotive builders in this country. Among them were Matthias W. Baldwin, William and Septimus Norris, of Philadelphia ; Thomas Rogers, William S. Hudson and the two Cookes, of Paterson, N. J. ; Ross Winans, of Baltimore ; Holmes Hinkley, of Boston ; William Mason and Mr. Fairbanks, of Taunton, Mass. The histories of these remarkable men have never been adequately written.



WALTER McQUEEN.

Mr. McQueen was born in Sterlingshire, Scotland, on October 8, 1817, and was, therefore, in his 76th year. He was the next to the youngest of eight children —five sisters and two brothers. In 1830 his parents emigrated to this country and located at Perth, in Fulton County, N. Y. Mr. McQueen's first employment in machine business was as a feeder of a horse-shoe machine in the Burden Iron Works, in Troy, N. Y. This was about the year 1835. Later he began an apprenticeship with William B. Many, of Albany, who carried on a general machine business and manufactured steam engines and did mill work. In 1838, after having completed his term of service there, Mr. McQueen erected the first stationary engine put up in Gloversville for the glove trade. In this same year Mr. McQueen went with Eaton & Gilbert, of Troy, the original firm of the present Gilbert Car Company. Their works at that time were on the site of the present Union Railroad Station, in Troy.

In 1839 Mr. McQueen made a visit to his old home in Scotland, and remained there for some time in the shops of the Messrs. Napier, in Glasgow, and while there worked on the first Cunard steamship which was built by this firm.

In the fall of the same year he returned to this country and secured employment with the Hudson & Berkshire Railroad, at Hudson, N. Y., of which Mr. Waterman was then Master Mechanic. He remained there until 1843, when he went to Schenectady, and was employed by the Utica & Schenectady Railroad Company. Two years later he went to Albany as Master Mechanic of the Mohawk & Hudson Road, which had been reorganized as the Albany & Schenectady Road.

During the four years he remained in this position Mr. McQueen built five locomotives for the road, and also rebuilt one which came from England in 1831. He also built at this time an engine with a 15 × 22-in. cylinder, which was named the *Mohawk*. In 1848 the *Mohawk* established a reputation for itself and for its builder by beating a Norris (Philadelphia) locomotive in a trial haul of cars up the grade at Schenectady. The Norris was a much larger locomotive than the *Mohawk*, and hauled only 16 cars to the *Mohawk's* 26.

About the same time he also built an engine with a single pair of driving-wheels and a pair of small trailing wheels behind, and having 12 × 18 in. cylinders and 4½ ft. wheels. This engine had a transverse spring over the trailing axle which extended from one driving-box to the other. By means of a screw on the foot-board this spring could be compressed or relaxed so as to throw more or less weight on the trailing wheels. In starting, the weight would be taken off of these wheels, thus increasing the load on the driving-wheels. After the train was started the spring was screwed up, and some of the load was then taken off of the drivers. This, perhaps, was one of the earliest "traction increasers," a favorite idea with inventors ever since. The engine referred to, with one car attached, carried the governor's message from Albany to Schenectady in 24 minutes, or the exact schedule time of the Empire Express of to-day.

In 1848 Mr. McQueen left Albany for New York to accept the position of Master Mechanic of the Hudson River Railroad, which was then being constructed from New York to Peekskill. He built the old shops at Thirtieth Street near the East River. The road was not completed to Albany until 1851.

In 1852 Mr. McQueen left the Hudson River Railroad to accept the place of Superintendent of the Schenectady Locomotive Works. While occupying that position this company built 1,000 locomotives of different designs. He was the originator of a number of marked improvements in locomotive construction, and the McQueen locomotive acquired a distinctive reputation the whole country over, and has been the subject of many harangues in innumerable engine houses and while trains were quietly waiting on side tracks. In 1847 he applied air and vacuum chambers on locomotive pumps, to lessen the shocks and concussions due to the rapid working of the plungers. This improvement was afterward universally adopted until injectors displaced pumps. He was also the first to use a cast-iron cylinder saddle attached to a cylindrical smoke-box. With the modification that half of this saddle is now cast on each cylinder, this improvement has also come into general use.

In 1876 he resigned the position of Superintendent of the works and was elected Vice-President. Since then he had practically retired from the business. In all his dealings during his long business career the deceased followed a course of the strictest integrity, and commanded the esteem and respect of all with whom he came in contact. By adhering to pure business principles, utilizing his natural talents and putting his acquired abilities to such uses that they became of benefit to mankind, he rose from comparative obscurity to a position of importance and wealth.

Walter McQueen was married in 1842 to Charlotte Augusta Cole, who died in 1879. The deceased is survived by five children—Hon. D. P. McQueen, Mrs. Joshua Barker, and Mr. Henry B. McQueen, of Schenectady ; Mrs. F. A. Beckwith, of Cleveland, O., and Mr. Robert F. McQueen, of New York.

For most of the particulars of Mr. McQueen's life we are indebted to the daily papers of Schenectady.

P. J. Flynn.

P. J. FLYNN, the civil engineer, died at Los Angeles, Cal., June 1, after a short illness, of congestion of the brain. Mr. Flynn was a recognized authority on hydraulic engineering, and was for a number of years in the service of the British Government in India, employed on some of the most important engineering works in the empire, and was also engaged in extensive irrigating works on this continent. He was the author of several standard text-books on engineering, which are accepted by the profession throughout the world. He only published his last work a few months ago, which met with a ready sale, he having received a large order from London and also several from India, and would, in a short time, have been independent from the royalties. Mr. Flynn was a native of Ireland, and was 55 years of age at the time of his death. He leaves no family.—*Los Angeles Times.*

HOURS OF LABOR ON BRITISH RAILWAYS.

AT a recent hearing at the British Board of Trade a deputation of signalmen was heard who urged that the Railway Servants (Hours of Labor) Bill should be amended by the insertion of a *maximum* with regard to the hours of labor of signalmen.

Mr. Mundella, in reply, said that any excessive hours of labor imposed upon signalmen would be of the utmost danger to the public; but the bill applied to all railway servants, from the station-masters downward—400,000 men; and it must therefore be elastic. He had brought in a bill stronger than any other which had been introduced on the subject, which not only gave powers to, but imposed duties upon the Board of Trade. If it appeared to the Board that there was in the case of any railway company reasonable ground of complaint with respect to the hours of labor of any class of railway servants, the Board was required to order the company within a specified time to submit such a schedule "as will in the opinion of the Board bring the actual hours of work within reasonable limits." If the company failed to do that they could be brought before the Railway and Canal Commissioners, and if they failed to comply with any order made by the Commission they were liable to a fine of £100 a day. He asked the signalmen to wait and try the act.

In discussing the subject, Sir J. Gorst said the State had a right to interfere with the hours of labor of railway servants, because they were the servants of the public. The State had a right to see that persons so employed were not unreasonably worked, and the State had a right to interfere with the hours of labor of railway servants for the purpose of protecting the traveling public against the risk of accidents.

THE COLUMBIAN EXHIBITION.

"WRITING a letter or an article on the Great Fair is attended with somewhat the same difficulties that would be encountered in preparing an essay on, say, the universe. It is difficult to know where to begin or what to say first. One of the recent aphoristic fads about art is that artists should paint, not what they see, but what they remember. According to this hypothesis, the impression produced on the painter should be represented on canvas, and not the scene as it is and as it appears.

"If this theory were adopted in writing about the Exhibition, it might be said in Japanese or Chinese English, *big;* MUCH BIG; *white;* MUCH WHITE; as the foreign correspondents delight in saying our great show is an apotheosis of bigness. Everything—the grounds, the buildings, the locomotives, the cheeses and Lake Michigan—are all bigger than they were at any other exhibition ever held.

Perhaps no better idea can be given of the scale of the Exhibition than to quote a description from a recent number of the London *Times*, an authority certainly not prejudiced in favor of American achievements. We quote this description, as it is a very good one, and because there can be no suspicion that the American eagle has been allowed to influence its data. In the description referred to it is said:

"Briefly stated, the World's Fair is a vast aggregation of buildings and ornamental grounds covering a park of 586 acres on the southwestern shore of Lake Michigan, about 6 miles south of the center of Chicago. It has a coast line of a mile and a half fronting the lake, with the buildings spread along this entire distance, and also upon interior lagoons which have been dredged in the park to add to the attractions. Out in front a long wooden pier of 2,500 ft. is built into the lake to make a steamboat landing. A broad basin, dredged inland behind the pier, opens into the series of lagoons which extend a mile to the northward. The great buildings surround the basin and a spacious plaza to the westward, and also front upon the lagoons, the magnificent high-domed Administration Building standing in the center of the plaza. This grouping makes a most impressive array of colossal buildings. To the northward of the lagoons are numerous buildings representing foreign nations and the States of the American Union, each emblematic of its nationality, and out in front of these, on the lake shore, two-thirds of a mile above the long pier, is the British Victoria House, in a conspicuous position, having the huge reproduction of an American naval battleship alongside it, behind a protecting breakwater. . . .

"There are over 150 buildings of all kinds on the grounds, and all the greater buildings were long since finished, although final touches of painting and decoration are still being given to some of them. They are by far the finest collection of structures ever built for a World's Fair, and include some of the grandest ever erected. The larger structures, which if all united in one building would cover 130 acres, are the following, their dimensions being given in feet, with the floor and gallery space for exhibitors estimated in acres, and the cost of each:

BUILDINGS.	Dimensions.	Space, Acres.	Cost.
Administration	262 × 262	4.5	£92,643
Manufactures	1,687 × 787	44	345,486
Machinery	842 × 494	17	234,779
" Annex	551 × 490	6.2	
" Boiler-house	1,103 × 86	2.2	
Agriculture	800 × 500	15	131,737
" Annex	550 × 312	4	
Electricity	690 × 345	9.3	84,670
Mining	700 × 350	8.5	53,306
Transportation	960 × 256	9.4	96,636
" Annex	850 × 435	8.5	
Horticultural	998 × 251	8	59,730
Fisheries	361 × 162	1.4	43,534
" Two Annexes	135 diameter	.7	
Fine Arts	500 × 320	4.6	147,562
" Two Annexes	220 × 136	1.4	
Women's	398 × 199	3.3	27,080
United States	421 × 351	5.5	80,000
" Battleship	348 × 69	6	20,000
Illinois	450 × 160	5	50,000
Forestry	528 × 208	2.6	16,404
Railway Station	300 × 150	4	45,077
" Train shed	672 × 150		
Dairy	200 × 94	.8	5,862
Leather	625 × 150	4.3	17,888
Live-stock	440 × 260	2.5	12,452
Saw mill	300 × 136	1	4,359
Music-hall	246 × 140	.7	73,251
Casino	246 × 140	.7	
Peristyle	600 × 60	.9	
Pier and breakwater	2,500 × 250	11.5	64,313
*Art Institute (in Chicago)	.....	....	40,000
Choral hall	.....	....	17,349
Anthropological	.....	....	17,133
Service offices, etc	.....	. ..	42,057
Children's	.....	....	4,443
Monastery La Rabita	. ...	...	5,861
Packing-case storehouse	.....	....	7,173
Total	.....	....	£1,840,785

"Besides stating these figures, I will also quote the following, showing some of the chief items of expenditure outside of the buildings:

Pumping works for water supply	£47,347
Constructing lagoons and harbor	157,560
" roads and walks	66,484
" bridges	17,178
" railways	85,915
" fire and police stations, etc	54,436
Grand fountains	24,500
Water pipe and sewerage	92,121
Statues and sculpture	34,392
Electric plant	148,397
Boilers and machinery	72,758
Decoration and coloring	31,643
Colonnade and obelisk	19,789
Architects' expenses	24,810
Dedication ceremonies	44,232
Salaries of officials and clerks	105,139
Publicity and promotion	32,764
Total	£1,061,463

"Such is the scale, material and financial, of this enormous show. It would be too much to say that all is finished, even now, but there is enough now on the square mile of surface of Jackson Park to occupy weeks in thoroughly seeing, and any visitor who pays his 2*s.* admission fee can now spend the day in examining an exhibition which beats in bigness anything ever attempted in this line outside of Chicago."

The most decided impression which probably most people will take away with them, after trying to see what is spread

* Intended for public meetings in connection with the Fair.

before the public in Jackson Park, is that they have had one of the biggest "tireds" that they have ever experienced.

Few people realize the limitations of their own capacity for seeing things. During the Centennial Exhibition, in Philadelphia, it was often amusing to see people who came there with excursion parties, and with only one day to see all that was to be seen. In the morning, when they first entered the grounds, the slightest event or object would attract their attention. About four o'clock in the afternoon they could be seen walking down the middle aisle of the great building, with their eyes fixed with a stony stare into space, utterly incapable of looking or seeing anything more. Their curiosity was completely satiated, and the limits of their capacities of observation had been exceeded. The same scenes are re-enacted daily at Chicago, with the superadded fact, which has not received the condemnation which it deserves, that the management has not provided seats, or had not when our observations were made, at all adequate to the wants of visitors. It was painful to see frail women and fat men, and other human beings in all conditions of exhaustion and fatigue, seeking vainly for some place to sit down. This neglect is cruel, inhuman and brutal, and the reason assigned for it was more so, and was that certain concessions had been given on the roofs of the buildings and elsewhere, and one of the privileges going with them was the providing of seats, and that it would take away some of the profits of those holding the concessions if visitors were provided with facilities for sitting down elsewhere. This want of seats detracted very much from the pleasure and added greatly to the discomfort of visits to the grounds, and it was reported that a physician remarked that the management must either provide more seats or enlarge the hospital accommodation in the Park.

Railroad men and engineers will naturally be attracted most to the Transportation Building and to the Machinery Hall, and what will appeal most to their imaginations in each place will be, the locomotives in the one and the stationary engines in the other.

Altogether there are more than 50 modern locomotives—not including the ancient relics—on exhibition. In order to correspond with the predominant idea of the Fair, they are nearly all big locomotives, and the question of a lady who came to the writer while he was making notes and asked if he would not please tell her "Why they made them so big," was perhaps not so foolish as it seemed. At any rate, it was very hard to answer.

Modern American practice is very well represented. About all the types of locomotives and details of construction which are now current are shown. All the principal kinds of compound engines are shown, and some comments thereon will be found on our editorial page. There are Belpaire fire-boxes, radial stays and old-fashioned crown-bars. There is not a modern locomotive, however, in the American exhibit which has any other form of valve-gear excepting the link-motion. Among the French and English exhibits there are a number of different types of valve-gear; one—a French or Belgian engine—which looks like a mechanical nightmare. With the exception of the Shay-geared locomotive, exhibited by the Lima Locomotive and Machine Company, all the modern American engines seem to be characterized by great conservatism in design, whereas some of the foreign engines are fearfully and wonderfully made. There is no striking novelty among the American engines, although there are many details which are interesting.

Every draftsman should see and study a series of drawings of locomotives in the French Department. They are works of art. It is doubtful whether it would be possible to have any such work done in this country—that is, whether a draftsman could be found who is artist enough to do it.

The exhibit of the Baltimore & Ohio Railroad has already been described in these pages—that is, an account has been given of what was intended to be exhibited. At the time we last saw it, it was still incomplete. The old locomotive and models of others were all in place, but the pictures—photographs, paintings and drawings—of which there are about 1,700, were not all in place. A great deal of time could be spent in examining these. There has never been brought together so much material from which a history of the locomotive could be made, and it is to be hoped that when the Exhibition is ended that this unique collection may be preserved. There is besides these the much-written-about *John Bull* and the rebuilt *De Witt Clinton;* and one of the most frequent questions which was asked in the Locomotive Department by women and boys was, to be directed to "the first locomotive that ever run." It was not always certain whether they meant the *John Bull* or the *De Witt Clinton* or some other engine, and they always seemed to be disappointed on being told that neither of them was the "first locomotive that ever run" either in this country or in any other.

In a publication like this anything like a full description of the exhibits is impossible. A mere catalogue or enumeration of the exhibitors and the objects exhibited would occupy more space than we could possibly give to it. All that we can do, and all that will be attempted, will be to make notes of features which are more than usually interesting, and even in doing that we will not undertake to make any strict classification of the relative interestingness of different objects.

As a counterpart of the Baltimore & Ohio historical exhibit of locomotives, that in the German Department, showing the evolution of rails and track, is very interesting. It begins at the very beginning of railroads, when the old tram rails were used, and shows each successive step of development, including the great variety of different rails which have been laid at various periods, stone-block, wood, cast iron and steel sleepers. A short section of each kind of track is put down with sleepers, ballast and rails all complete.

A great variety of cars are also on exhibition. The Pullman and the Wagner companies have each a train consisting of cars of the various kinds provided by them. The magnificence and luxury of these makes it difficult to find adjectives which will do justice to them. The Canadian Pacific and the London & Northwestern roads also each have a train of the different kinds of passenger cars used on their lines. Besides these there are other cars for passenger and freight, for horse, steam and electric roads, the mere enumeration of which would occupy several pages of our paper.

Leaving the complete cars and locomotives and coming to their details, we find extensive exhibits of such things as car brakes and signals in great variety. Nearly every railroad man will be surprised to see so many different kinds of air-brakes exhibited. He who tries to understand the different systems of signals which are exhibited will find that it will require an amount of study almost as great as would be needed to be admitted to the bar, if he is not already a lawyer. Tired men and women gaze longingly on exhibits of car-seats, which display their potential comforts in the most exasperating way. Whether at the same time they anathematize the administration for not supplying seats in other places is not known, but if they are not members of church it would seem to be their duty to do so.

It may be added that the Exhibition is the despair of editors of technical papers. Some of them are like the man who was recently asked what he thought of the financial situation, and who answered that he had been trying with all his might to think something and couldn't—he could only feel—feel that he was dreadfully hard up. It is so with some of "us." Before going to Chicago "we" were intent on some systematic scheme for describing or discoursing on the Exhibition. It may be frankly confessed that we now have no such scheme; as none which we could devise was at all commensurate with the magnitude of the Great Fair, we have been compelled, like our financial friend, to confess our inability to think anything adequate to the occasion, and now we only *feel* that the Exhibition is greater than our capacity for describing it, and that THE AMERICAN ENGINEER AND RAILROAD JOURNAL is very "hard up" for space in its pages, which are too few and too small to describe all or even a small part of the interesting things which may be seen in Jackson Park.

NOTES AND NEWS.

European Coal Fields.—A Prussian mining expert has made investigations of the coal strata of the world, and expresses the belief that the coal deposits of Austria-Hungary, France, and Belgium will be exhausted in five centuries at most. Those of Great Britain and Russia will follow, and last of all the German strata will give out. The American coal deposits, he estimates, will not last longer than those of Europe.

Panhandled Trestle.—The panhandled trestle and bridge over the Tuscarawas River, west of New Comerstown, O., has been completed. The entire bridge is 450 ft. long, each truss being 153 ft. Owing to the location, the high water and the nature of the ground, the work of building the temporary trestle was attended with a great deal of danger. The trestle is in the shape of a "run around" and is over 600 ft. long.

A Novel Street Railway.—Ontario, Cal., has a street railway that is operated partly by horse-power and partly by gravity. When the town was founded an avenue 200 ft. wide was laid out with a space in the center for a street car line. This avenue is 6 miles long, running from the town of Ontario to the mountains, with a steady ascent varying from 100 to 250 ft. to the mile. In December, 1888, the railroad was com-

pleted and horse-cars put on. A couple of ingenious mechanics, J. B. Tays and James Birch, decided that the horses might as well ride on the down trip, and accordingly designed a small platform-car, which slides under the main car, for the descent. On this the horses ride down, the car running by gravity. The arrangement has been in successful use since March, 1889. The down trip is regularly made in 30 minutes, but the cars sometimes come down in half that time without stops. The horses or mules take very kindly to the arrangement.

The Electric Stop.—Those who are in a position to judge of its merits are emphatic in their endorsement of the new electric stop motion which is now being applied to spinning machinery, covering automatically, as it does, the unguarded places in the machinery. In the arrangement of this mechanism the two rolls between which the yarn passes are each connected with a pole of a battery; when the yarn breaks, the rolls immediately come in contact with each other, thus closing the circuit and actuating an electro-magnet, which stops the machinery instantly. In case the yarn, instead of passing on, becomes wrapped around the rolls, the increased thickness of the material forces the upper roll against a pin also connected with the battery, and the machinery is stopped as before.

A Curious Clock.—A curious clock, destined for the World's Fair at Chicago, has been made by a clockmaker at Warsaw named Goldfaden, who has worked at it six years. The clock represents a railway station, with waiting-rooms for the traveler, telegraph and ticket offices, a very pretty, well-lighted platform, and a flower garden, in the center of which is a sparkling fountain of clear water. Past the railway station run the lines. There are also signal-boxes, signals, lights and reservoirs—in fact, everything that belongs to a railway station to the smallest detail. In the cupola of the central tower is a clock which shows the time of the place. Every quarter of an hour the station begins to show signs of life. First of all the telegraph official begins to work. A long line of people form at the ticket office to buy tickets; porters carry luggage; the bell is rung, and out of the tunnel comes a train, rushing into the station, and, after the engine has given a shrill whistle, stops. After a third signal with the bell, the engine whistles, and the train disappears into the opposite tunnel, the station-master and his assistant leave the platform, and the doors of the waiting-rooms close behind them.

Peat as Fuel.—The recent attempts to use peat in smelting iron and under locomotive boilers have been naturally looked upon with great interest in Ireland, which country has practically no coal, while one seventh of its whole surface, or 3,000,000 acres, consists of peat bog. Dr. Emerson Reynolds, who has given much time to the study of the subject, states that peat compares very unfavorably with coal in many ways. It is five times as bulky as coal, it contains from 15 to 25 per cent. of water, and seldom less than 10 per cent. of ash, and, bulk for bulk, its thermal value is only one-thirteenth of that of coal. The fresh peat, moreover, contains 35 or 40 per cent. of moisture, making necessary considerable expense for drying. During a coal famine some 20 years ago, Dr. Reynolds proposed converting the undried peat into gas, and this was successfully done in the shops of an Irish railway, the efficiency of a ton of peat used in this way for working up scrap iron being 60 per cent. of that of a ton of coal used as gas by the same method. Since then the extraction of ammonia from gasified peat makes this process more practicable. A promising new suggestion is that peat shall be used in making water gas, which can be conveniently supplied for domestic and industrial purposes.—*Invention.*

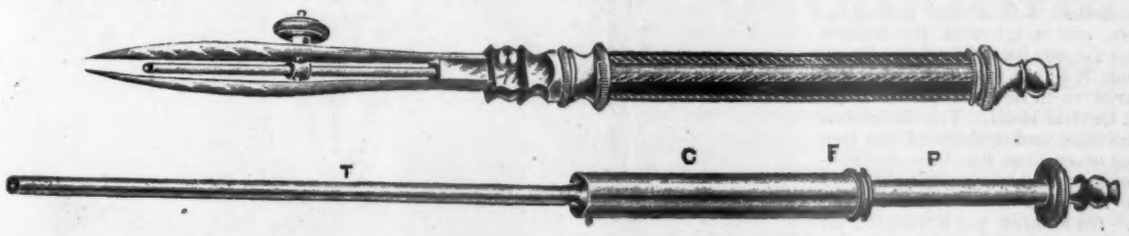
Freak of Electricity.—A curious freak of electricity has been discovered in connection with a leak in the mains of the Indianapolis Gas Company. In Illinois Street, buried 4 ft. deep, is a main that has been down for 52 years. It was abandoned 22 years ago because of its size, but the pipe is still in an excellent state of preservation. When the Citizens' Street Railway Company sunk its trolly-line poles in the ground, they were placed close to this abandoned main: some of them were flattened and rested against the pipe. The insulation wore off the top of the pole, and the iron became charged with electricity. The current ran down the pole into the ground until it came in contact with the cast-iron main, against which the pole rested. At that point the current burned a hole through the post and through the cast-iron gas-pipe. The current ran along this cast-iron pipe for 200 ft. north, where it came in contact with a 1¼ in. wrought-iron service-pipe that crossed the old artificial main. At the junction of these pipes the current again showed its power by burning large holes in both pipes, and the melted metals formed into small globules, like shot, perfect in size and form, and these dropped into the old pipe. The gas released from the service-pipe followed south on the old main until it reached the electric post, and entered into the tube through the hole burned out by the current. The post was soon full of gas. A car passing made a spark that set it on fire, and the flames burst from the top of the pole. An examination of the service-pipe and the old main found them to be in excellent condition.

Large Steamers for the Southern Pacific Railroad.—The Southern Pacific Railroad announces that the Newport News Ship-building and Dry Dock Company is making preparations to build two 10,000-ton steamships at its plant. The site is now being piled for the blocking to carry the immense weight of the vessels. They are to ply between New Orleans and Liverpool.

Manufactures.

RESERVOIR DRAWING PEN.

We illustrate herewith a neat and ingenious arrangement of drawing pen that meets a want felt by every draftsman when engaged on heavy line work, and which is being placed upon the market by Messrs. Jackson Brothers, Limited, 50 Call Lane, Leeds, England. The constant dipping and wiping which are required under such circumstances with an ordinary pen, is a source not only of loss of time, but of constant annoyance, while it often results in the drawing or work becoming smeared and soiled from traces of ink accidently left about the fingers. In the pen shown, a reservoir for holding a supply of ink is fitted inside the holder, which, when once charged, will serve to keep the pen supplied for a considerable length of time. The arrangement of the pen will readily be seen on reference to the accompanying illustration. It consists of an ordinary



hinged-nib drawing pen, provided with a hollow metal handle, into which fits a cylinder *C*, which is shown withdrawn from the handle in the lower illustration. The rod or plunger *P* serves to draw the Indian ink into the cylinder *C*, while the tube *T* is provided to carry the ink to between the nibs of the pen; the whole reservoir attachment, as will be seen from the lower illustration, constituting in reality a miniature hand pump.

In using the pen the cylinder *C* is withdrawn from the handle by the milled gland *F*, the cylinder being charged by dipping the end of the tube *T* into the ink and pulling out the plunger *P* to its extreme position. The whole cylinder is then replaced in the handle, without, of course, disturbing the plunger, a slight push forward of which serves to replenish the supply in the nose of the pen as fast as it is exhausted. If it is desired at any time to interrupt the work, it is only necessary to blow out the ink remaining between the nibs of the pen, and the ink in the cylinder will keep good for days; while, further, if a line or two is required to be added to a drawing when the reservoir is empty, this can easily be accomplished, since the pen can be used exactly as an ordinary drawing pen; and if the reservoir becomes accidentally lost or damaged, an excellent drawing pen still remains; while, it may be added, the price of the pen, 4s., is less than is often charged for ordinary hinged-nib drawing pens of similar quality.

THE EXPOSITION FLYER.

THE daily papers have made the fact very generally known that the New York Central & Hudson River and the Lake Shore & Michigan Southern roads have put on a new train—the "Exposition Flyer"—between New York and Chicago, which makes the run westward in 20 hours, and eastward in 20 hours and 15 minutes. On its first trip this train left New York on May 28th with a number of invited guests besides other regular passengers. The writer was among the party, and had a threefold purpose in making the journey—one to accept the hospitality of the officers of the New York Central Railroad Company, another to be a participant in the running of this first fast run and observe its phenomena, and, third, to visit Chicago and see the great show.

It should be added, perhaps, that this run was made just too late to be reported in the last number of THE AMERICAN ENGINEER, and therefore this somewhat belated account is given.

The train left New York at 3 P.M. on the date named, and made the run of 964 miles in 20 hours, or, to be exact, in two minutes less. There were nine scheduled stops, and several extra ones were made by reason of signals and other causes. The train consisted of one combination baggage, buffet and library car, with barber-shop and bath-room, approximate weight, 80,000 lbs.; three 16 section sleeping-cars, approximate weight, 96,400 lbs. each, making the total weight of cars in train 369,200 lbs. The engines used on the New York Central Road were like the one of which we have published illustrations in the article on American and English Locomotives during the present year. The weight of these engines with their tenders loaded is 203,500 lbs., making the maximum total weight of train 572,700 lbs. The average weight of train would, of course, be less, as the tender would not always be fully loaded. Besides these cars a dining car was taken on from Albany to Syracuse, and from Toledo to Chicago. Its weight was also about 80,000 lbs., making the maximum weight of the train 652,700 lbs.

The engines used on the Lake Shore Railroad were built by the Brooks Locomotive Works, and have 17 × 24 in. cylinders, 6-ft. wheels and 52-in. boilers, and weigh with the tenders loaded 174,600 lbs. The Lake Shore engines, it will be seen, are not nearly so large as those used on the New York Central Road. The difference in the size and weight of the two classes of engines has been the subject of a good deal of comment since these trains have been put on the road. On another page we give an engraving and description of the valves used on the Lake Shore engines. From this it will be seen that they are of the Allen type, with an exceptionally long travel and supplementary ports ⅛ in. wide. Indicator diagrams taken from these engines with these valves would be very interesting. The speed on the Lake Shore Road is 46.5 miles per hour, while on the New York Central it is 50.6. The engines on the latter road are built not only for hauling these fast trains, but must often be used for hauling trains of 10 and 12 cars at somewhat slower speeds. It would be interesting to know how the Lake Shore engines handle trains of this size.

The cars composing the train were all new, and have the Gould vestibule and the Leonard platform and hydraulic buffer. This is the invention of Mr. Arthur G. Leonard, Secretary to Mr. H. Walter Webb, Third Vice-President of the New York Central. The cars rode with remarkable steadiness; and the speed of the train did not impress those riding in it as being remarkably fast. The secret of the quick time is that it keeps at a regular rapid jog all the time, and the stops at stations are very short. On arriving at stations everything is in readiness, the inspectors begin their work at once, the engines are changed quickly, and there is little or no baggage to load or unload.

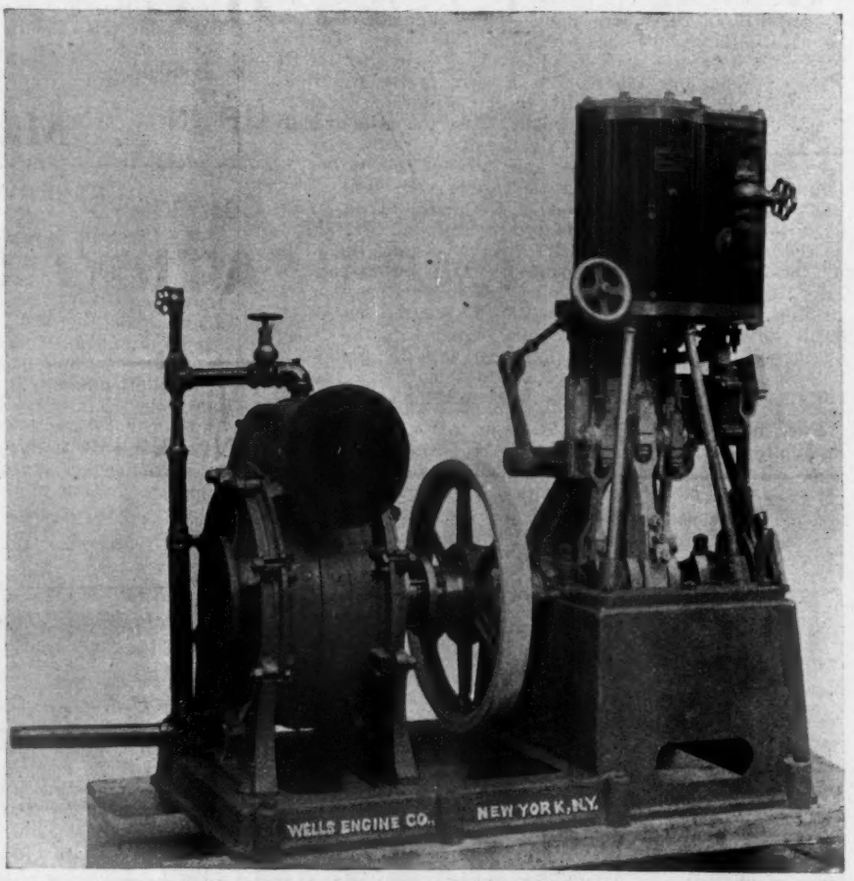
The officers of the New York Central assign much importance to heavy rails in fast running, believing that it is much safer and easier to maintain a high speed on stiff rails than it is on those which have more or less sensible deflection. There seems no room to doubt the practicability of making the run from New York to Chicago in 18 hours if the Lake Shore Line was relaid with heavier rails.

The return trip on the Exposition Flyer, which was made about 10 days later, was as successful and as prompt as the westward trip. In both cases the train arrived at stations slightly ahead of time.

THE WELLS ENGINE.

THE steeple compound engine which we illustrate, and which is shown as driving a centrifugal pump, is made by the Wells Engine Company, of 91 Liberty Street, New York. The fundamental principles of the engine consist in the fact that the two pistons move in opposite directions to one another at all times, and with the same velocity, so that the reciprocating parts are practically balanced, and the engine will run with great speed upon its own base without the necessity of using holding-down bolts.

The proportions of the engine are such that the weight of the high-pressure piston, with its rod, cross-head and connecting-rod, weigh exactly the same as the low-pressure piston with its double rod, two cross-heads and two connecting-rods.



THE WELLS COMPOUND ENGINE.

The engine is operated by the Stevenson link motion, and is readily and easily handled.

The low-pressure cylinder is above the high-pressure, which is contrary to the usual construction of steeple compound engines; but this construction is followed with these engines on account of the two piston-rods which are used in connection with the low-pressure piston, and which straddle the high-pressure cylinder, coming down and taking hold of the two cross-heads on either side of the high-pressure cross-head. The engine is especially adapted for work where it is desired to make the best possible use of the steam, and at the same time where jar is very undesirable. This makes the engine especially valuable for yachts and work where it is impossible to put down a solid stone foundation. The engines are built in sizes ranging from 3-in. and 6-in. × 5-in. cylinders, up to 12-in. and 24-in. × 16-in. The same system has been carried out in quadruple expansion engines.

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(REVISED EDITION.)

THIS BOOK is intended for a large class of readers, among whom are all kinds of railroad officers and employees, consisting of locomotive engineers, firemen, and the many different kinds of mechanics employed in railroad shops and in the construction of locomotives and other railroad machinery and material. Besides these, there are many amateur engineers, students, and persons interested directly or indirectly in railroads, and a not inconsiderable class who are always seeking information on all subjects whatsoever. It is evident, therefore, that the only way to adapt a book of this kind to all the classes for whom it is intended, was to make it so plain that the "way-faring man" would have no difficulty in comprehending it. It has therefore been written in as simple and plain language as the writer could command, and the subjects presented are explained with the least possible employment of either scientific or practical technicalities.

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AMERICAN ENGINEER AND RAILROAD JOURNAL.
(Formerly the RAILROAD AND ENGINEERING JOURNAL.)

PUBLISHERS' DEPARTMENT.

NEW ADVERTISEMENTS.

THE attention of readers is called to new advertisements of the following firms and companies in this number of the AMERICAN ENGINEER AND RAILROAD JOURNAL:

BUFFALO DUST GUARD & OILER COMPANY, Buffalo, N. Y. Dust Guards and Oilers; p. xxxiii.

ERIE MALLEABLE IRON COMPANY, Erie, Pa. Malleable Iron Castings; p. xxxiii.

W. P. HARRISON & COMPANY, Columbus, O. "Home Electric Motor;" p. vi.

POPE MANUFACTURING COMPANY, Boston, Mass. Bicycles; p. xx.

SIMONDS ROLLING MACHINE COMPANY, Boston, Mass. Balls, Pins, and Track Bolts; p. x.

SYRACUSE TWIST DRILL COMPANY. Measuring Machines; p. xiv.

UNITED STATES GOVERNMENT. Interstate Commerce Commission Order Relative to the Height of Railroad Car Drawbars; p. xxviii.

PENNSYLVANIA RAILROAD EXHIBIT AT THE WORLD'S FAIR.

A COMPLETE ILLUSTRATION OF THE PROGRESS OF AMERICAN RAILROADS.—STRIKING CONTRASTS BETWEEN THE PAST AND PRESENT.

THE World's Fair visitor who finds his way into that vast enclosure by the Sixty-fourth Street entrance will come almost immediately upon a building as architecturally attractive as any of the minor structures in all the great White City by the lake; a building classical in detail as well as in general conception, standing in the midst of a plateau of greensward with walls the tint of old ivory, and garnished with flags that reflect the brighter hues of the rainbow. While it is an annex, so to speak, of the great red and green and gold Transportation Building across the way, it is an annex complete in itself, and within and without exhibits in an exhaustive manner never before attempted, much less accomplished, the beginning, progress, and development of railroading in the United States as exemplified by the Standard Railroad of America. It is, in fact, the Pennsylvania Railroad Company's own edifice, and it presents an interesting and scholarly showing of that corporation's history from the first inception of one of its component parts in 1815, when the first charter was granted to a railroad company in America to construct a road from Trenton to New Brunswick, N. J., to the present time, when it controls nearly 10,000 miles of road penetrating 13 States, and with termini in New York Harbor, at the National Capital, in three great cities of the Ohio Valley, and at five of the great lake ports.

While the building's main façade is perhaps the more beautiful of the two 140-ft. sides of the structure, the rear view will doubtless prove the more attractive to the student of railroad progress, in that it presents, with its attendant features, an excellent reproduction of a model Pennsylvania Railroad station of the present day, with signal tower, tracks, ballast, switches, frogs, overhead foot-bridge, fences, and gates. The tracks in themselves are as indicative as anything else of the marked development in this branch of mechanics in the last 60 years, the exhibit showing, in juxtaposition with as fine a specimen of the standard Pennsylvania rail of 1892 as has ever been rolled, pieces of the Camden & Amboy rail of 1831, of the rail used on the old Portage Road over the Alleghenies, and of the very crude wood and iron rail with which the Madison & Indianapolis Road was originally laid. Some idea of the contrast may be had when it is stated that whereas the Camden & Amboy rail weighed only 35 lbs. to the yard, the standard rail of to-day, of which the examples shown are 100 ft. in length, weigh 100 lbs. to the yard, being nearly three times as heavy.

Upon the tracks is another contrast even more marked. Probably the most conspicuous, and certainly the most interesting, object in the display is the original *John Bull* train, where here rests after its 1,000-mile journey across the Continent from New York. The old engine itself—the oldest in America—which was constructed by George Stephenson, in England, and brought to this country in 1831 for use on the Amboy Division of the Pennsylvania Railroad, stands there to-day precisely as it was in 1836, after having had added to it such improvements as were then suggested to the minds of the American engineers. Its weight, with its somewhat cumbersome tender, is only 32,100 lbs., as against 100 tons, the weight of the ordinary standard passenger locomotive of to-day, and beside the modern machine, of course, it looks very much like a toy. The passenger coaches, glistening with a fresh coat of green paint, are so low that a tall man cannot stand upright within them; their brakes are worked by means of handles similar to those on the horse-cars of the present time, and the only method of lighting them is by a tallow dip in each end of each car. As example of the magnitude to which the railroad cars of to-day have attained, no better choice could have been made than the selection for exhibit, side by side with this tiny passenger train, of the two tremendous vehicles on which the mammoth Krupp guns were whirled from Baltimore to the Exposition; the manner in which the guns were carried being shown by means of full-size models, made of staff, of the standard 16-in. and 10-in. guns, such as are now used by the United States War Department.

This policy of contrast, which is so apparent without the building, is carried throughout the entire display, and the interior, with its relief maps, charts, models, lay figures, photographs, and relics, gives a better idea of the wonderful growth of the greatest railroad system of the country than could possibly be had in any other way. The walls of the great marble-floored hall, into which the visitor may enter from either the front or the rear, are lined with handsome mahogany showcases, while the columns, so arranged as to form a colonnade on each side, are surrounded by folding frames for the display of thousands of exhibits that could be shown to advantage in no other way.

In arranging the display, the smallest details have not been neglected, and as an indication of the thoroughness with which these little matters have been looked after, the labelling of the objects with a descriptive label in five languages is especially noteworthy.

In the centre of the building, under the dome, upon a platform shaped like a Greek cross, are three relief maps that are certain to attract no little notice. They illustrate the changes in the methods of crossing the Alleghenies from the year 1832 to the present time, and have been prepared with such great care as to have won words of high commendation from scientists, whose attention has been called to them. One of these in particular, the largest of the three, which is 12 ft. long by 4 ft. wide, and which shows the old portage and the new portage roads, together with the present line of the Pennsylvania Railroad, including the Horseshoe Curve, Allegrippus, and the district of the Johnstown flood, is especially valuable as being the first and only relief map ever made of that section. The original map, from which the basis of the present work was obtained, was one which belonged to the late J. N. DuBarry, Vice-President of the Company. It was in lead-pencil, never having been filled in in ink, and was traced, so the legend runs, by President J. Edgar Thomson himself. The other two relief maps, or models which form two arms of the cross, show the Horseshoe Curve and Plane No. 1, with canal-boat, cars, and locomotives.

The rest of the floor space between the colonnades is dotted with pedestals and platforms upon which are models relating particularly to the developed system of transportation of to-day. On one side, for instance, is a beautiful reproduction in miniature of the double-decked ferry-boat *Washington*, one of the fleet plying between Jersey City and New York. In every particular the model maker has closely followed the original, and has succeeded in turning out a piece of work as nearly perfect in every detail as it is possible to imagine. On gala days it is proposed to decorate this little vessel with bunting, and arrangements have been made to light the interior with electric lights precisely as the boat from which it is copied is lighted. The method of handling freight cars in New York Harbor is shown here in the same way by means of models of a tug-boat and float. Toward the other end of the building are lay figures in uniform of the several classes of employés of the Company.

An object of considerable interest to many is a perspective map, 33 ft. long, showing the position of each train in motion